Plenary I: AEESP Lecture

The Great Smog Caper. RICHARD FLAGAN, *California Institute of Technology*

The 2026 AAAR conference has come to Pasadena where the science of photochemical smog started. Leo Cabrillo labeled southern California's San Pedro harbor the Bay of the Smokes in the 1530's. Four centuries later, Arie Haagen-Smit, a Dutch biochemist, joined the Caltech faculty at a time the local mountains disappeared in the haze with increasing frequency. When the plants he was studying began to suffer, he sampled the air to find the culprit and, after finding organic nitrates in the brew, deduced the role of nitrogen oxides in automobile emissions in producing ozone, and volatile organic compounds in producing the dense brown haze in the Los Angeles smog. Chemists at the University of California at Riverside, farther downwind from LA, explored the chemistry behind the smog. Young William E. Wilson working at the National Air Pollution Control Administration convinced key researchers to study the haze, leading to the 1969 "Great Smog Caper" in which Ken Whitby, Sheldon Friedlander, Bob Charlson, George Hidy, Peter Mueller, Dale Lundgren, Benjamin Liu, brought their instruments and students to Caltech in Pasadena to measure the smog aerosol. Primitive by today's standards, their measurements yielded critical new insights into atmospheric aerosols. Particle size distribution measurements spanning from 6μm to 3nm revealed several peaks in the size distribution that pointed to diverse sources and mechanisms in the aerosol dynamics – stimulating fundamental experimental and theoretical studies that form the foundation of modern aerosol science and development of early models of photochemical smog formation. The Great Smog Caper is a cornerstone of aerosol science and the air quality engineering that followed. This lecture will provide a glimpse into the origins of our science, and some of the challenges that the pioneering participants into the Great Smog Caper faced that we, fortunately, no longer have before us.

Plenary II: Lundgren-Marple Lecture

The Aerosol Aqueous Phase and the Curious Behavior of Fine Particle Acidity. RODNEY J. WEBER, *Georgia Institute of Technology*

Motivated by the breadth and importance of the aerosol aqueous phase in atmospheric chemistry and the chemical environment within fine particle water, a central theme of my research has been developing measurement tools to characterize its chemical composition. Early work led to the Particle-into-Liquid Sampler (PILS) for online measurement of water-soluble inorganic ions in ambient aerosols. This was extended to methods for quantifying water-soluble organic carbon (WSOC) and to ongoing work measuring aerosol oxidative potential and its links to adverse health effects.

Of all the chemical properties of atmospheric fine particles, pH and aerosol liquid water content (LWC) are among the most consequential and least directly measured. These quantities are tightly and bidirectionally coupled: pH governs gas-particle partitioning of semi-volatile species that drives changes in particle water content, while LWC dilutes ionic concentrations, directly setting pH. H^+ concentration also mediates secondary organic aerosol formation and the dissolution of transition metals that contribute to particle oxidative potential and adverse human health effects. LWC is itself an environmentally significant quantity, serving as the medium for aqueous-phase reactions, modulating particle optical properties and $PM_{2.5}$ mass through semi-volatile species uptake and subsequent reactions. Despite this outsized influence, the field has often relied on proxy approaches—ion balance, molar ratios, and other simplified indicators—that misrepresent particle acidity and fail to capture the complex coupling between pH and particle water. The difficulty in making direct measurements of either quantity in ambient fine particles, combined with thermodynamic models' ability to explore their sensitivity to various parameters, makes accurate computation currently the most viable means of assessing these important properties.

Drawing on ground and airborne field campaigns, I explore the intriguing behavior of fine particle acidity and liquid water content, highlighting findings that show fine particles are remarkably and persistently acidic across many continental environments. This acidity paradox is maintained by thermodynamic interconnections involving buffering by semi-volatile species and coupling between various chemical species and aerosol liquid water—the same coupling that makes LWC itself a key and perhaps underappreciated driver of $PM_{2.5}$ composition and environmental impact. The broader implications of these findings for atmospheric chemistry, air quality regulation, nitrogen deposition, and public health will also be discussed.

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Plenary III

The Changing Face of U.S. Air Quality: Two Decades of Rising Contributions of Mineral Dust. JENNY HAND, *Colorado State University*

Mineral dust is the most abundant aerosol by mass in the atmosphere and influences everything from respiratory health and aviation safety to regional hydrology and climate forcing. However, quantifying its impacts remains a challenge due to the lack of consistent dust definitions and sampling methods, sparseness of monitoring stations in dust-influenced regions, and the lack of continuous monitoring. In this presentation I will address some of these gaps by analyzing long-term speciated data from the U.S. IMPROVE network using two key dust metrics: fine mineral dust (FD), derived from PM2.5 elemental markers, and coarse mass (CM). These data are used to estimate the spatial and seasonal variability in dust from which sources and transport may be inferred. This analysis reveals a significant shift in the U.S. particulate matter budget: as secondary inorganic aerosols have declined due to regulatory successes, the relative contribution of mineral dust has increased. In the western U.S., FD now frequently accounts for 50% or more of the PM2.5 budget during the spring. These findings indicate that in certain regions, dust is no longer a background contributor but rather a driver of air quality, with spatial footprints ranging from local emissions to intercontinental transport. Despite its significance, sparse monitoring often leads to 'missed' dust events in national assessments, obscuring the true extent of its impact. As climate change is projected to increase aridity and dust mobilization, understanding these trends is vital for mitigation strategies and climate assessments.

Plenary IV: Friedlander Lecture

The Indoor Air Microbiome. JORDAN PECCIA, *Yale University*

The air inside homes and other occupied buildings contains a complex ecosystem of bacteria, viruses, fungi, and allergens originating from outdoor air, building surfaces, pets, and human occupants. People spend most of their time indoors, and concentrations of bioaerosols are often higher indoors than outdoors, thus, our most important microbial exposures occur within buildings. The health effects of these exposures are well established for infectious diseases, asthma, and allergies. Less understood, however, is how microbial exposures at different stages of life shape the human microbiome and influence long-term health.

This plenary talk will address three central themes related to the indoor air microbiome. The *first* is the composition of the indoor air microbiome. Indoor microbial communities are largely assembled through dispersal processes driven by physical phenomena, including deposition, building envelope penetration, and resuspension. These microbes originate from outdoor air, building surfaces, pets, and human occupants.

Second, the dispersive mode of community assembly necessitates the integration of aerosol science and engineering with microbiome science. Together, these disciplines provide a framework for understanding microbial exposure and how building design, operation, and interventions influence both the composition of and exposure to the indoor microbiome. Despite their strong complementarity, these fields are rarely integrated.

Third, evidence supporting the concept of a healthy building microbiome will be presented. The human microbiome is increasingly recognized as a “second genome” that influences immune function, respiratory health, metabolism, and other physiological processes. The strongest evidence comes from studies of asthma and allergy development, where early-life exposure to buildings with diverse microbial communities and specific microbial taxa is associated with improved health outcomes. Current research seeks to identify the characteristics of beneficial and harmful indoor microbiomes, as well as how building design and operation can promote healthier microbial environments.

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1AP.1

Rayleigh Spherical Particle Scattering and Absorption, the Lorentz-Lorenz Factor, and the Fröhlich Resonance. HANS MOOSMÜLLER, Kurt Ehlers, Prakash Gautam, Raiya Ebini, Christopher M. Sorensen, *Desert Research Institute*

The optical properties of small particles in the Rayleigh regime provide fundamental insights into light–matter interactions relevant to aerosols, colloids, and engineered nanomaterials. Here, we present a systematic analysis of scattering and absorption by homogeneous spherical particles through the lens of the complex refractive index (CRI) plane. Using the Lorentz–Lorenz factor, we separate the dependence of Rayleigh scattering and absorption on particle size and CRI, enabling a clear visualization of optical behavior as function of CRI, independent of size parameter. Contour representations of scattering and absorption in the CRI plane reveal distinct regions governing the sensitivity of scattering and absorption to variations in the real (n) and imaginary (κ) components of the refractive index. Within the CRI range studied ($0 \le n \le 3$, $0 \le \kappa \le 3$), we identify three regimes for scattering and four for absorption, each characterized by different monotonic dependencies on n and κ. Attention is given to the role of the Fröhlich resonance, where both scattering and absorption exhibit singular behavior due to enhanced dipolar polarizability. Although most atmospheric and colloidal particles lie away from this resonance, its influence extends throughout the CRI plane and can significantly affect optical responses. Extensions to non-spherical particles are briefly explored using prolate spheroids, demonstrating the emergence of multiple resonance conditions driven by particle shape. These findings provide a unified framework for interpreting and predicting particle optical properties and for future investigations and applications ranging from atmospheric sensing to the design of advanced optical materials.

1AP.2

A Novel Microphysical Model for Emergent Phenomena in Multiphase Single Aerosol Particles: Crystallization, Nanoparticle Locking and pH. FRASER CRAWFORD, Jonathan P. Reid, Walther Schwarzacher, *University of Bristol*

An evaporating droplet undergoes many varied microphysical processes such as evaporative cooling, internal circulation and pH change from CO2 dissolution that can give rise to complex emergent behaviour. Single droplet measurement techniques used to explore these systems generally only offer black box views into a small portion of evolving aerosol properties. The reliability of measurement methods such as elastic light scattering are also particularly vulnerable to changes in particle morphology. This makes a full mechanistic picture of a particle's evolution over its entire lifetime hard to draw with measurement alone. Kinetic multi-layer models of aerosols have found great success in exploring combined processes at the single particle level.

In this work, a novel kinetic multi-layer model for general aerosol microphysics is presented and applied to electrodynamic balance measurements of droplets undergoing morphology change. Enhanced transport of nanoparticles by external air flow is shown via delayed nanoparticle locking and is compared against expectations from Hill's spherical vortex, with good agreement. Additional transport mechanisms such as nanoparticle displacement are also explored. The model is also used to examine the heterogeneous nucleation of NaCl onto AgBr nanoparticles, providing insight into NaCl diffusion at steep supersaturations. Additionally, the model is also applied to carbonate buffered droplets to explore the relationship between relative humidity, droplet size and time dependent pH.

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1AP.3

FTIR Spectroscopy of Desert Dust: Implications for Complex Refractive Index Spectra and Dust Sample Diversity. ANSEL LAVITZ, Adriana Rocha Lima, Hans Moosmüller, *University of Maryland, Baltimore County*

Mineral dust is a dominant natural aerosol that has a strong influence on Earth's radiative budget. However, its radiative impacts remain poorly constrained due to limited knowledge of its complex refractive index (CRI), especially in the thermal infrared (TIR). We present a new application of Fourier Transform Infrared (FTIR) Attenuated Total Reflectance (ATR) spectroscopy to derive CRI spectra for six dust samples in the TIR, 2.5–25 μm. The CRI was estimated through two distinct methods. The first utilizes the Beer–Lambert Law to determine the imaginary component of the CRI, κ(λ), whereupon the real component, n(λ), is retrieved via the Kramers–Kronig relations. The second implements a direct ATR reflectance inversion approach where n(λ) and κ(λ) are simultaneously retrieved by fitting modeled Fresnel reflectance to measured ATR spectra. This methodology circumvents uncertainties associated with many sample preparation methods, thus enabling a more direct characterization of natural samples. Comparisons with literature CRI spectra for the six samples in question (and for mineral dust broadly) provide context for interpreting results from both retrieval approaches. For each sample, the two methods capture the same major absorption features as available literature does, but differ in retrieved absorption magnitude and long- wavelength behavior. Additionally, ATR measurements revealed significant variability in CRI spectral shape and magnitude, reflecting sample diversity linked to geographic origin. These results provide new constraints on desert dust optical properties and highlight sample-to-sample variability that can inform climate and radiative transfer models.

1AP.4

Capabilities of Digital Holography for In-Situ Aerosol Characterization. MATTHEW BERG, *Kansas State University*

Light-scattering techniques are commonly used to characterize micron and submicron particulate matter, such as aerosols, in a rapid and contact-free way. A typical objective is to infer the size and shape of particles from their light-scattering patterns. While this approach can be useful for simple shapes, difficulties arise for large irregularly shaped particles. An alternative, well-suited for comparatively large particles, is digital holography. A particle is illuminated by a beam and the interference pattern produced by unscattered and scattered light is recorded by a sensor. The pattern is the hologram, and from it, an image of the particle can be rendered computationally. Using red, green, and blue lasers along with a color sensor enables color holograms of particles, from which color images can then be generated. Yet, other important characteristics of aerosol can be obtained from holograms including the extinction cross section, spatial distribution, and dynamics of particles. A new concept suggests the possibility to determine the material phase of certain particles as well. We will discuss these capabilities and suggest useful applications in various areas of atmospheric science.

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1AP.5

Studying Single-Particle Phase Transitions of Mixed Organic/Inorganic Aerosol Particles with a Low-Cost Aerosol Optical Trap. ALI ALOTBI, Evan Dalton, Cara Waters, Ryan Davis, Andrew P. Ault, *University of Michigan*

Studying phase transitions of atmospheric aerosol particles is important for understanding the phase-dependent chemistry that can occur within particles as well as how particles will scatter radiation in different environments and ultimately influence Earth's climate. Aerosol optical trapping is an experimental technique that lends itself well to characterizing phase transitions at the single particle level as the particle is free from contact with surfaces that could change the mechanism or kinetics of these processes, and key environmental factors governing the particle phase state, such as relative humidity (RH), can be carefully adjusted to characterize changes in RH-dependent physical properties. In this work, a low-cost, counter-propagating, dual-beam optical trap composed of a Bessel beam and a Gaussian beam is used to study RH-dependent phase transitions (efflorescence) of atmospherically-relevant aqueous inorganic particles. Additionally, mixed organic/inorganic particles are trapped and exposed to decreasing RH to assess how the presence of organic species affects the dynamics of particle efflorescence at the single-particle level. A homologous series of organic acids (malonic acid, malic acid, and citric acid) are added to the particles as a proxy for atmospherically-relevant hygroscopic organics and are used to understand how the presence of increasingly hygroscopic organic species can affect the dynamics of particle efflorescence free from contact with any surfaces that could interfere with the dynamics of these processes. The results of this study demonstrate the functionality of the low-cost optical trap and further inform how the chemical properties of atmospheric particles determine their evolving behaviors in a changing environment, and ultimately how their climate-influencing properties can change over time at the single-particle level.

1AP.6

Light Absorption by Nitroaromatic Brown Carbon Chromophores: Insights from Particle Levitation. PEDRO DE ALLENDE, Malsha Amugoda, Katelyn Pacaud, James F. Davies, *University of California, Riverside*

In this study, the real and imaginary refractive index (*n* and *k*) of oxidized nitroaromatic brown carbon (BrC) chromophores were determined using an LQ-EDB coupled with broadband light scattering (BLS) spectroscopy as a function of pH and relative humidity (RH). The direct radiative forcing induced by aerosols containing these chromophores is largely unconstrained due to uncertainties in their dynamic microphysical properties. Bulk solution spectroscopy, as a method to determine *k*, cannot fully describe aerosol particles that exist in metastable states. However, BLS measurements on levitated particles allow for the determination of *k* at atmospherically-relevant, metastable, supersaturated chromophore concentrations. Although previous studies have characterized *k* at single or limited wavelengths, in this work the complex refractive index of BrC-containing aerosol particles was determined across a range of wavelengths (400 to 700 nm). The measured *k* was found to increase with chromophore mass fraction and decrease with RH, consistent with concentration effects, with an additional strong dependence on molecular structure and pH. These measurements may be coupled with radiative forcing efficiency analyses to provide further constraints on the optical properties of these chromophores and their impact on climate. The wavelength-dependent complex refractive index of these chromophores is determined and used to quantify their radiative impacts through calculation of the particle single scattering albedo, ω(λ), asymmetry parameter, g(λ), and backscattering fraction, β(λ).

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1AP.7

In Situ Measurements of Submicron Aerosol Particle Physicochemical Properties via Fluorescence. PAUL OHNO, *Auburn University*

The physicochemical properties of aerosols, including phase state, pH, and viscosity, have proven challenging to directly measure in situ. Here, the utility of fluorescence probe spectroscopy as a versatile tool for the elucidation of these critical physicochemical properties in submicron particles in situ while they remain in suspension under realistic atmospheric conditions is demonstrated. A general methodology for the introduction of fluorescent probes into pre-existing aerosols of interest is discussed. This method critically expands the applicability of the fluorescence probe-based techniques to particles generated in an atmospheric chamber or sampled from ambient air. The use of polarity-sensitive fluorophores for characterizing hygroscopicity and phase state, viscosity sensitive molecular rotors, and pH-sensitive fluorophores is all discussed, in measurements ranging from ensemble average to single-particle measurements. Finally, the outlook of this technique towards in situ, comprehensive physicochemical characterization of fine aerosol particles is discussed.

1BA.1

High-Throughput Platform to Probe Bioaerosol Viability and Transcriptional Dynamics. Allen E. Haddrell, Xia Yi, Robert Alexander, Kennedy Peek, Darryl Hill, Andrew Davidson, Tristan Cogan, Jamie Mann, Adam Finn, JONATHAN P. REID, *University of Bristol*

Bioaerosols (airborne microbes like bacteria, viruses, and fungi) impact health, agriculture, and even climate. While current tools can measure their presence, improved technology is needed to study how microbes behave, adapt, and why they decay once airborne. A deeper understanding of these processes is essential for developing targeted strategies to control disease spread through enhancing airborne microbe decay, and design effective immunizations.

In 2019, we reported the development of an innovative technology to study bioaerosol. The Controlled Electrodynamic Levitation and Extraction of Bioaerosol onto a Substrate (CELEBS) takes a profoundly different approach than those that predate it, wherein small populations of near identical bioaerosol are probed at a very high time resolution. This approach has enabled insights into how, and why, microbes lose viability in aerosol, and factors that impact disease transmission.

We will reported is the development of the next iteration of the CELEBS technology: Quadrupole Electrodynamic Levitation and Extraction of a Bioaerosol onto a Substrate (QELEBS). QELEBS allows for an extremely large population of near identical bioaerosol of a range of size to be levitated for prolonged periods of time in controlled conditions. At a given time point, a quantifiable subpopulation of droplets is extracted from the system for offline analysis. The ability to readily study a large population of aerosol enables high throughput, high performance, and reproducibility. QELEBS supports stable levitation and quantitative recovery of >>500 droplets, enabling reproducible measurements of microbe survival/cellular outputs across relative humidities of <10 to >90% over timescales from seconds to hours. The system resolves humidity-dependent survival dynamics, reduces variability relative to CELEBS. QELEBS allows for a broad range of microbiological studies far beyond what can be achieved with CELEBS. Recovered droplets also yield sufficient nucleic acid for quantitative PCR, linking aerosol microphysical environments with both phenotypic and molecular analyses.

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1BA.2

Photocatalytic Disinfection of Antibiotic-Resistant Bioaerosols Using Cu-Doped TiO2: Impact of Reactor Hydrodynamics and Operating Parameters. CHINMOY MANDAL, Prashant Nawale, Manoranjan Sahu, *Indian Institute of Technology Bombay*

Indoor bioaerosols and escalating antimicrobial resistance represent formidable global health challenges as conventional filtration often fails to neutralize airborne pathogens. While TiO_2 photocatalysis offers a sustainable solution for active disinfection, its efficacy is frequently constrained by wide bandgap requirements and poor reactor-level mass transfer. This study presents a systematic investigation of the enhancement of photocatalytic bioaerosol disinfection using copper-doped TiO_2 under ultraviolet and near-visible light irradiation. TiO_2 and Cu-doped TiO_2 nanoparticles (1-5 wt.%) were synthesized, immobilized onto stainless steel substrates, and evaluated within a novel, custom-designed recirculating baffled photocatalytic reactor. Computational fluid dynamics was employed to characterize reactor hydrodynamics and residence time distributions, providing critical insights into airflow patterns that govern bioaerosol-catalyst interfacial interactions. Integration of Cu into the TiO_2 lattice significantly improved photocatalytic performance by narrowing the band gap, suppressing electron-hole recombination, and enabling near visible light responsiveness. Among the synthesized materials, 5% Cu-TiO_2 exhibited the highest antimicrobial efficacy. The influence of key operational parameters, including flow rate, exposure time, and relative humidity (RH), was systematically evaluated to determine optimal performance criteria. A critical dependence on residence time was observed; increasing the flow rate from 1 to 5 L min^{-1} resulted in significant decline in disinfection efficiency from 36.5% to 12.8%. Conversely, inactivation efficiency scaled with exposure time, reaching a peak of 82.6% at 90 minutes. Furthermore, an optimal RH of 60% was identified as the threshold for maximum performance, balancing generation of oxidative radicals with availability of active catalytic sites. Under these optimized conditions, the system achieved maximum disinfection efficiencies of 93.87% for cefotaxime-resistant *E. coli* and 87.84% for isoniazid-resistant *Mycobacterium smegmatis*. These results demonstrate that while Cu-doping fundamentally enhances intrinsic activity of TiO_2, the synergistic optimization of reactor hydrodynamics and operating parameters is essential for achieving high-efficiency air-phase disinfection.

1BA.3

Effects of Environmental Conditions on Airborne Virus Decay by Using Electrodynamic Levitation Techniques. ZHENYU MA, Emily Hong, Hunter Richards, Herek L. Clack, *University of Michigan*

Airborne pathogens are responsible for the spread and transmission of various infectious diseases. One key factor affecting disease transmission is the decay of infectivity of airborne pathogens while they are suspended in the air. Recent scientific studies have demonstrated the role of aerosol pH in reducing the infectivity of respiratory viruses in the exhaled-breath environment, while details, such as the timescale of these processes and the virus-specific relationship, remain debated. More specifically, the equilibrium of carbon dioxide (CO_2) between the volatile components in exhaled aerosols and the rapidly changing atmosphere surrounding them is considered critical to aerosol pH changes and associated effects on viral aerosol infectivity. (Haddrell et al., 2024) Other gas species may also contribute to the decay of infectivity (acceleration or preservation) via their pH-altering potential in specialized contexts, such as ammonia in poultry production.

One challenge in studying the infectivity changes of airborne viruses is keeping the viral aerosol suspended in the air while maintaining environmental conditions. Recent technology over the past decade has focused on using electrodynamic levitation to suspend aerosols by charging them upon generation and placing them in a controlled electric field. This study uses the technology known as Controlled Electrodynamic Levitation and Extraction of Bioaerosols onto a Substrate (CELEBS), which can generate a few dozen droplets with designated composition, capture them in an electrodynamic trap, keep them suspended in air for tens of seconds to over one hour on demand, and deposit them onto a collection medium. (Fernandez et al., 2019)

In this study, we will use CELEBS technology to assess the infectivity decay of viral aerosols using surrogate viruses, such as bacteriophage MS2 and Φ6, by introducing novel environmental conditions like gas mixture compositions. The relationship between aerosol pH and infectivity can be studied and inferred using CO_2 measurements. Preliminary results indicate that the CO_2 concentration in the CELEBS chamber begins at elevated levels compared to standard atmospheric conditions, then decreases over time during levitation of carbonate-containing aerosols. We will carry out infectivity assays on viral aerosols suspended for different periods of time and combine them with recorded CO_2 levels to study the CO_2 evolution trend, in addition to expanding the experiment to varying relative humidity and gas composition like CO_2 and NH_3, in order to explore the potential effects of common indoor environments on the virus infectivity decay.

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1BA.4

Survival of Legionella in Droplets Exposed to Sulfur Dioxide. THI THUONG THUONG CAO, Amy Pruden, Linsey Marr, *Virginia Tech*

Legionnaires' disease (LD) is a severe pneumonia caused by *Legionella* bacteria. LD incidence has risen markedly over the past two decades in the United States, particularly in the Northeast. During the same period, ambient sulfur dioxide (SO_2) concentrations have declined due to regulations on coal-fired power plants. LD outbreaks are commonly linked to building water systems, such as cooling towers, where *Legionella* can grow and become aerosolized in droplets. Once airborne, these droplets can absorb atmospheric trace gases, including SO_2, leading to acidification that may influence bacterial viability. The objective of this study was to investigate the effects of SO_2 on the viability of *Legionella pneumophila* in microdroplets. One-microliter droplets containing *L. pneumophila* strain ATCC 33823 were deposited onto quartz slides at three relative humidity (RH) conditions (33%, 54%, and 75%). Droplets were exposed to SO_2 at concentrations of 50 ppb, 100 ppb, and 1 ppm at 33% RH. In bulk buffer medium, the bacteria maintained greater than 50% viability at pH 5.0-7.0 for up to one week. In contrast, viability declined to approximately 6% at pH 4.0 and was completely lost at pH 3.0 and 2.0 within 6 hours. In 1-µL droplets of tap water without SO_2 exposure, bacterial viability decreased similarly over time at 33% and 75% RH when normalized to the mass of water remaining in the droplets, while more rapid loss in viability was observed at intermediate RH (54%). Notably, *L. pneumophila* remained viable for up to 15 minutes after complete droplet evaporation at 33% RH. We expect that increasing SO_2 concentrations will further reduce viability through enhanced droplet acidification. These findings support the hypothesis that air pollution control - driven reductions in SO_2 may unintentionally influence the risk of airborne *Legionella* transmission and emphasize the need to better understand the role of atmospheric chemistry in pathogen survival.

1BA.5

Organic Components Modulate Respiratory Syncytial Virus Survival in the Combined Aerosolization and Evaporation Stage at Low RH. YUHUI GUO, Deepak Sapkota, Ajay Sajan, HoangDinh Huynh, Jeffrey Kahn, Hui Ouyang, *The University of Texas at Dallas*

Studies have demonstrated that organic components can modulate airborne virus survival during both aerosolization and suspension stages. For respiratory syncytial virus (RSV), aerobiology studies remain limited, and organic impacts on RSV survival have not been investigated. We used a custom-built flow-tube system to aerosolize RSV-laden particles from different bulk solutions at 30% ± 2% relative humidity. Bioaerosols were collected simultaneously using BioSamplers at a 12.5 L/min sampling flow rate at two locations, ensuring suspension times of 10 s and 70 s. Four bulk solutions were tested: virus medium (VM) prepared with MEM supplemented with 10% FBS, and VM supplemented separately with sucrose (50 g/L), porcine mucin Type II (3 g/L), or BSA (3 g/L). Viral viability and RNA persistence were quantified using the TCID50 assay and droplet digital PCR, respectively. Aerodynamic Particle Sizer measurements at both sampling locations quantified particle loss in the flow tube. At 30% RH with 10 s suspension time, all particles were desiccated. SEM-EDX analysis revealed that VM particles contained visible crystalline structures centrally located beneath a thin organic layer, while particles from supplemented solutions showed uniform chemical distribution. Relative survival ratios at 10 s compared to bulk solution viability varied by matrix composition, with 50 g/L sucrose providing the strongest protection. BSA preserved RSV slightly better than mucin. Relative survival rates at 70 s compared to 10 s viability, corrected for RNA loss, were similar for sucrose and BSA, which both exceed the VM-only case. These findings demonstrate that organic influences RSV aerosol stability in the combined aerosolization and evaporation stage at low RH. Future studies are needed to fully uncover the organic impacts on RSV survival to improve our transmission risk assessment under various indoor RH conditions.

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1BA.6

Detectable Influenza RNA in Recipient Breathing-Zone Aerosols During Trial of Transmission from Naturally Infected Donors. ANNA PULLEY, Madison L. Sawyer, Amrita Mandal, Akshaya Ganesh, Grace Herron, Briana Jacobs, Mariana Lim, Emily Liu, Tam-My Nguyen, Alycia Smith, Kristen K. Coleman, S.-H. Sheldon Tai, Gautam Vanama, Shengwei Zhu, Thaís Ferreira, Jonathan Vyskocil, Jelena Srebric, Donald K. Milton, *University of Maryland*

Background: In a previous influenza transmission trial, we did not detect virus in the breathing zone of Recipients (Lai et al, 2026). Possible explanations included minimal aerosol shedding by naturally infected Donors and rapid air mixing in the room used for the trial. Here we measured personal exposure of Recipients exposed to influenza Donors in an indoor air research facility with limited air mixing.

Methods: In February 2026, we recruited two cohorts of Donors with community-acquired influenza A and B infections and healthy Recipients from a university campus. During each cohort, Recipients were exposed to Donors in a climate-controlled room for 4-6 hours. We minimized air mixing and concentrated exhaled breath plumes within participant breathing zones using displacement ventilation. We sampled Recipient breathing zones using NIOSH personal samplers collecting 3 aerosol size fractions: coarse (>4µm), fine (1-4µm), and submicron (<1µm). We assayed viral load in each size fraction using digital PCR.

Results: Viral RNA was detectable in 78% of Recipient breathing zones during the redesigned transmission trial. In the first cohort, detectable influenza RNA was found in 9/10 (90%) of NIOSH samples from 3 Recipients exposed to 4 Donors (1 H3N2 and 3 influenza B infections). During the second cohort, influenza RNA was detected in 12/17 (71%) of NIOSH samples from 3 Recipients exposed to 10 Donors (all influenza B infections). Coarse aerosols were the dominant size fraction with 71% positive samples (range: 55-4762 RNA copies/m^3). Of the fine aerosol samples, 39% had detectable influenza RNA (41-372 RNA copies/m^3) while 32% had detectable RNA in the submicron stage (59-583 RNA copies/m^3). Donor cough counts during exposure events and sequencing data demonstrating Donor sources are pending.

Conclusions: Using a large number of Donors and minimizing air mixing resulted in quantifiable exposure to influenza aerosols among Recipients in a shared space.

1BA.7

Application of BioCascade Impactor in Hospital Environments for Detection of Airborne Pathogens. MOHAMMAD WASHEEM, Sudheer Salana, Amin Shirkhani, Luis Angel Nino Barreat, Arantzazu Eiguren-Fernandez, Jiayu Li, Trishul Siddharthan, Roberto Ruiz-Cordero, Chang-Yu Wu, *University of Miami*

Airborne pathogen surveillance in healthcare settings remains limited by the lack of practical sampling platforms that can sustain long-duration collection while preserving sufficient airborne biological material for size-resolved, untargeted characterization of pathogens in clinical air. To address this gap, we deployed BioCascade 2.2 (BC-2.2), a size-fractionating bioaerosol sampler with temperature control and stage-specific water injection, for hospital air sampling in an outpatient clinic room. BC-2.2 collects particles into liquid medium in three size fractions (>10 µm, 10–4.1 µm, and 4.1–1.5 µm) and was operated with a downstream BioSpot-VIVAS collector to obtain long-duration, size-resolved liquid samples for untargeted whole-genome analysis using Oxford Nanopore sequencing technology. Sampling was performed across six study days. Each day included HEPA-filtered negative controls, a 30-minute baseline sample collected before room occupancy, one 2-hour BC-2.2 run spanning patient presence and post-visit decay, and parallel 30-minute BioSpot-only samples to assess the temporal persistence of airborne microbes.

Sequencing results showed that BC-2.2 recovered sufficient airborne nucleic acid for metagenomic characterization under clinical sampling conditions. The strongest sequencing output was obtained from BC-2.2 stage 2, corresponding to particles in the 10–4.1 µm size range. This dataset generated 1,247 contigs totaling 8,400,433 bases, with a mean contig length of 6,737 bp. Community profiles were dominated by bacterial signatures, with smaller eukaryotic contributions, and differed between pre-visit and post-visit samples. Shannon diversity increased after room occupancy, indicating a broader airborne microbial mixture following patient activity. Preliminary taxonomic profiling identified organisms of potential clinical relevance, including Burkholderia pseudomallei, Stenotrophomonas maltophilia, and Pseudomonas aeruginosa, together with other environmental and human-associated taxa.

These findings support the feasibility of combining BC-2.2 with untargeted long-read sequencing for hospital bioaerosol surveillance and linking particle size, room occupancy, and airborne pathogen signatures in clinical air.

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1BL.1 – INVITED

Celebrating the Lifetime Achievement of Benjamin Y. H. Liu, Professor, Inventor and Entrepreneur (1934-2025). DAVID Y. H. PUI, Francisco Romay, *University of Minnesota*

Dr. Benjamin Young-Hwai Liu (1934–2025), a Regents Professor at the University of Minnesota and pioneering aerosol scientist, passed away on June 30, 2025, at age 90. Founder of MSP Corporation and a National Academy of Engineering member, he was

instrumental in the founding of American Association for Aerosol Research, the journal of Aerosol Science and Technology, and the International Aerosol Research Assembly which hosts the International Aerosol Conference every four years.

Liu made significant and novel contributions to several scientific fields, including solar energy utilization, fundamentals of aerosol behavior, and instruments and techniques for aerosol generation, measurement, sampling and analysis. In total, he published approximately 400 peer-reviewed research papers, four edited books, and mentored thirty-six Ph.D. students. He held over 200 U.S. and foreign patents. His Ph.D. thesis and the published papers on "The Characteristics of Solar Radiation and the Performance of Flat-Plate Solar Energy Collectors" were among the most widely cited publications on the subject, even forty years later. However, he is perhaps best known for pioneering a large number of techniques in aerosol research; he made seminal contributions to aerosol sampling and transport, charging and precipitation, inertial impaction and filtration, and laminar and turbulent deposition. These inventions have a wide range of applications that benefited a number of different industries. During Liu's career, his measurement systems and approaches led to standard methods of particle size measurements for pharmaceutical inhalers, and the improvement of the yield of semiconductors.

1BL.2

Performance Evaluation of Low-Cost Condensation Particle Counters for Ultrafine PM Monitoring. FRANCISCO ROMAY, Brent Williams, David Y. H. Pui, *University of Minnesota*

There are now hundreds of low-cost optical-based sensors developed for community monitoring of PM2.5 and gaseous air pollutants. However, these sensors cannot detect ultrafine particles smaller than 100nm, which have much higher spatial and temporal variability. Additionally, ultrafine particles may have significant health effects related to respiratory, cardiovascular and nervous systems. Ultrafine particles do not contribute significantly to PM2.5 mass fraction but dominate the total particle number concentration (i.e. > ~90%). Condensation particle counters (i.e. CPCs) measure the total number concentration of ultrafine particles with high accuracy, but these devices are typically expensive and cannot be deployed outdoors. In this work, we evaluate two relatively new low-cost CPCs: the QuantAQ water-based CPC (i.e. MODULAIR-UFP), and the OpenAeros isopropanol-based CPC (i.e. OpenCPC). These new CPCs claim accuracies of 10 to 20% for concentrations up to 105 cm-3 and can be operated outdoors at temperatures as low as 0 ºC or lower, when properly mounted inside small weather-proof enclosures. We have tested these devices in the laboratory using NaCl and DEHS aerosols, and with ambient aerosols, both indoors and outdoors. Both low-cost CPCs show 10-15% accuracy with excellent linearity when compared to laboratory CPCs. The MODULAIR-UFP can detect atmospheric nucleation events due to its low 5nm detection cutpoint and operated down to º0 C and relative humidities above 20%, while the OpenCPC can detect particles larger than 10nm and operate at temperatures as low as -15 ºC. These new low-cost CPCs demonstrate a new capability for larger scale deployment in outdoor areas with potential high ultrafine particle concentrations, such as residential areas close to highways, airports, transit hubs, and some industries.

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1BL.3

Field Deployment of an Open-Source Condensation Particle Counter for Residential UFP Monitoring and Portable Air Cleaner Performance Evaluation. Aaron Collins, Joseph Stam, ROB CALDOW, *OpenAeros LLC*

Public health guidance and exposure limits for indoor particulate matter have largely been adopted from outdoor air quality standards, relying on mass-based PM2.5 metrics. However, emerging evidence suggests that count-based metrics may better represent human exposure and health risk, particularly for UFPs, which contribute negligibly to aerosol mass yet dominate particle number concentration and surface area, properties linked to biological reactivity and systemic translocation. Despite this, UFPs are rarely monitored in residential settings due to the cost, noise and odors associated with traditional condensation particle counters (CPCs).

This study presents multi-week field deployments of the OpenCPC®, a low-cost, open-source CPC, across three occupied residences encompassing varied building ages, housing typologies, and heating systems. UFP number concentrations were measured concurrently with PM2.5 mass, >0.3 µm optical counts, and CO_2 using a distributed low-cost sensor network. A daily crossover design evaluated portable air cleaner (PAC) effectiveness across alternating 24-hour periods with PACs active and disabled.

PAC operation produced substantial reductions across all residences. In the single-family hydronic heated home, PACs reduced mean UFP concentrations by 54–91% and PM2.5 by 79–99% depending on room location and data treatment. The apartment residence showed comparable UFP reductions of 78–81% in an occupied bedroom. The forced-air residence yielded more modest reductions, suggesting mechanical ventilation may dilute PAC effectiveness. High-resolution temporal data from the OpenCPC enabled in-situ PAC characterization through exponential decay analysis, allowing effective air change rates (eACH) to be estimated across UFP and optical particle measurements.

Correlation analysis across residences showed weak-to-moderate agreement between UFP number concentrations and PM2.5 or >0.3 µm optical counts, indicating that mass-based and optical metrics are likely unreliable UFP surrogates. These findings demonstrate that accessible CPC technology enables routine UFP monitoring and distributed PAC deployment provides an effective mitigation strategy across residential environments.

1BL.4

A Compact, Battery-Operated 1 Nanometer Condensation Particle Counter: Laboratory Characterization and Field Deployment on a Tethered Balloon for New Particle Formation Studies. CHONGAI KUANG, Darielle Dexheimer, Casey Longbottom, Carlos Ruiz, *Brookhaven National Laboratory*

Aerosols play an important role in the Earth's energy balance on local to global scales due to their direct interactions with incoming solar radiation, and indirectly via their role as potential cloud condensation nuclei. Accurate prediction of aerosol impacts on this energy balance therefore requires an understanding of the processes that strongly enhance aerosol number concentration, such as new particle formation (NPF) from the photochemical reaction of gas-phase precursors. Recent advances in the development of condensation particle counters (CPCs) have enabled the detection of gas-phase single molecules and molecular clusters down to 1 nanometer in diameter and below using new CPC working fluids (e.g., diethylene glycol) and operating principles - this new capability has enabled the direct observation of the first steps of NPF. While there have been numerous NPF measurements from the surface, there have been relatively few measurements aloft, especially from aerial platforms, which are increasingly needed as evidence grows of the importance of atmospheric dynamical and meteorological controls on where and when NPF occurs. To address this observational gap, a compact, battery-operated CPC was adapted to operate on a tethered balloon system (TBS), and was modified to measure aerosol concentrations at particle diameters down to 1 nanometer. Laboratory characterizations of the modified CPC will be presented, including: the particle size-dependent droplet pulse height spectra, the detection response to sub-3 nanometer nano-condensation nuclei (e.g., neutralizer-generated ions, organic vapors), and the instrument stability in conditions meant to approximate the ambient operating environment on a TBS. We will also present initial observations of the modified CPC deployed on a TBS at an atmospheric observatory managed by the U.S. DOE Atmospheric Radiation Measurement (ARM) user facility, and sited within the Bankhead National Forest (BNF) in Northwestern Alabama.

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1BL.5

HoloCMA: A Holographic Eye on Coarse-Mode Aerosols. JIARONG HONG, Nikil Krishnakumar, Ryne Juidici, Nicholas Bravo-Frank, Shibo Wang, Qisheng Ou, Francisco Romay, Chongai Kuang, Naruki Hiranuma, David Y. H. Pui, Wing Lai, *Particle4X, Inc.*

Coarse mode aerosols (CMAs), including pollen, spores, dust, and other large atmospheric particles, are important atmospheric constituents, yet detailed, real-time characterization of their size, morphology, and type remains limited. We present HoloCMA, an imaging-based platform for real-time, particle-resolved analysis of CMAs. By integrating digital inline holography with deep-learning-powered computational methods for particle detection and classification, HoloCMA extends conventional measurements of size distribution and number concentration by extracting morphology and type at the single-particle level. Specifically, the current system analyzes particles from 5 µm to the millimeter scale at flow rates up to 27 L/min. HoloCMA was validated at the Particle Technology Laboratory at the University of Minnesota using a TSI Aerodynamic Particle Sizer (APS 3321) and a Flow Focusing Monodisperse Aerosol Generator (FMAG 1520). NaCl, ammonium sulfate, sucrose, PSL, and oleic acid particles were generated with diameters from 5 to 12 µm, and HoloCMA measurements closely matched the expected geometric particle sizes for all five types of particles. For NaCl particles and oleic acid droplets, APS-derived geometric diameters showed greater uncertainty than HoloCMA measurements because the conversion from aerodynamic to geometric diameter depends on assumed particle properties, including density and shape factor. For number concentration, HoloCMA agreed with APS measurements within uncertainty for 5 µm particles, while higher HoloCMA concentrations at larger sizes were consistent with increasing APS particle losses. HoloCMA was also deployed during a month-long field campaign at Bankhead National Forest in southern Alabama, where it captured temporal variations in pollen and nonpollen particles and distinguished among pollen, spores, and nonbiological aerosols. These results demonstrate HoloCMA as an accurate and robust platform for real-time sizing, counting, and classification of CMAs.

1BL.6

SEMS Rapid Scanning Transfer Functions: Impact on Inversion. MARK KANAPARTHI, Suresh Dhaniyala, *Francis Marion University*

Accurate interpretation of Scanning Electrical Mobility Spectrometer (SEMS) measurements requires a complete description of the instrument transfer function, including non-ideal effects such as voltage reversals, smearing, and finite counting time intervals. In this work, the full SEMS transfer function is formulated using an arrival time framework that explicitly incorporates these effects, providing a more physically consistent representation of particle dynamics and detection.

It is commonly assumed that the particles that arrive during a scan are injected during the same scan. However, in real-world operation, particles arriving during the first few seconds of a selected scan might have been injected prior to the start of the scan, and thus the inversion of this data can be complicated. Because the charging fraction of nanoparticles, which are the particles typically expected in the first few channels, is small, even a small distortion in the number of particles arriving in these bins can significantly bias the inversion. Consequently, it is imperative to examine the particles arriving during the first few seconds of any scan, regardless of its duration.

Here, we model the SEMS transfer function considering the real-time voltage variation that alternates up-scan and downscan, with a constant voltage hold in between. For this operation, we obtain time-dependent transfer function and demonstrate the challenges of inversion of data close to the times when voltage trends are changed. This study establishes a practical framework for valid measurement regions within SEMS scans where inversion artifacts can be minimized.

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1BL.7

Implementation of Advanced Process Control in Wafer Cleaning Using Size-Classified Particle Deposition.
KYOUNGTAE KIM, Minsu Lee, Cheolwon Eo, Mihyun Yoon, Jeonguk Kim, Jaein Jeong, Youngjeong Kim, *Samsung Electronics Co., Ltd.*

Particle-induced defects remain a primary cause of yield loss in semiconductor manufacturing. The cleaning process is one of the key methods for controlling these defects. While intensifying cleaning processes enhances particle removal efficiency (PRE), it often results in reduced throughput and increased operational costs. To mitigate this fundamental trade-off, we propose an Advanced Process Control (APC) framework for intelligent wafer cleaning. This approach optimizes cleaning intensity by predicting incoming particle loads based on the process parameters and equipment states of preceding manufacturing steps, such as process time and wafer position within the tool, to adjust cleaning parameters dynamically. Implementing predictive APC requires extensive evaluation wafers to accurately simulate process-induced particles and quantify removal efficiency. However, acquiring wafers with specific particles attached from high-volume production is limited by metrology, availability, and reproducibility constraints. To overcome this, a Particle Deposition System (PDS, MSP 2300G3A) utilizing advanced aerosol control technology was employed to generate precise and standardized test wafers. The PDS enabled the precise deposition of various contaminants in particle form onto silicon wafer surfaces. These particles were systematically deposited in 12 distinct sizes (30 nm to 500 nm), with 2,000 particles precisely located at 12 designated spots per wafer. Using these PDS-generated standard wafers, we quantified the PRE of a specific cleaning process by evaluating four critical parameters: spray nozzle scan count, scan speed, N2 gas flow rate, and wafer rotation speed. Evaluation results indicated a strong positive correlation between PRE and both scan parameters and N2 flow rate. Conversely, wafer RPM showed a weak correlation with PRE and was excluded from the APC variable matrix. This study implements the APC framework based on a quantitative PRE database across three distinct cleaning processes. The proposed methodology enhances PRE compared to conventional methods, while maintaining existing productivity and operational costs.

1BL.8

Influence of Professor Benjamin Liu in the Development of Electrospun Nanofibers.
HOO YOUNG CHUNG, Shibo Wang, Francisco Romay, Qisheng Ou, David Y. H. Pui, *University of Minnesota*

Electrospinning is the second oldest man-made fiber forming technology. Even though the principles of electrospinning were discovered earlier, it has not been widely adopted industrially due to its low productivity and worker safety concerns.

Electrospinning has three periods of extensive research emphasis: 1910s in Soviet Russia, 1930s in Germany, and 1980s in the USA when Donaldson developed and introduced UltraWeb® nanofiber filters. The 1990s also received NSF-led focus on nanotechnology giving worldwide attention to electrospinning.

James Schaefer was the first graduate student of Prof. Benjamin Liu, which led the effort on the development of nanofibers for air filtration applications. Dr. Liu was highly sought as a mentor in air filtration research topics. Prof. Liu graciously mentored many young scientists, regardless of whether they were students at the University of Minnesota, or if they had differences in opinion and approaches in air filtration. I benefitted greatly from Prof. Ben Liu's wisdom and advice. I will share my personal experience with Prof. Ben Liu, my first and real mentor when I was at Donaldson company.

This will be a video presentation.

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1CC.1

Spatial Distribution of Atmospheric Ice-Nucleating Particles from Local to Synoptic Scales. RUICHEN ZHOU, Drew Juergensen, Kelton Ayars, Carson Hume, Kevin Barry, Oren Dutton, Gavin McMeeking, Ezra Levin, Anna Hodshire, Leah Gibson, Ethan Emerson, Paul DeMott, Jessie Creamean, Sonia Kreidenweis, Russell Perkins, *Colorado State University*

Ice-nucleating particles (INPs) are a key component of aerosol-cloud interactions. Extensive field campaigns have investigated INP abundance, properties, and sources, yet the representativeness of single-site INP measurements across different spatial scales remains poorly constrained. In this study, we examine this question using coordinated immersion-freezing measurements of INP concentrations from multiple sites during the Surface Atmosphere Integrated Field Laboratory (SAIL) and Tracking Aerosol Convection Interactions Experiment (TRACER) campaigns. At the local scale, INP concentrations were generally spatially homogeneous across tens-of-kilometer scales in complex mountain terrain and in an urban-rural environment. Occasionally observed spatial differences were mainly associated with INPs active at relatively warm temperatures. We further extend the analysis to synoptic scales by including measurements from SAIL, TRACER, and the Southern Great Plains (SGP) observatory. INPs from SAIL and SGP, which are separated by approximately 800 km, showed similar concentrations of cold-temperature INPs throughout much of the year, indicating spatial similarity at the synoptic scale. Comparisons with the coastal TRACER sites showed that INP concentrations differed substantially during marine air masses, but became more similar among SAIL, SGP, and TRACER, spanning over 1000 km, during continental air masses. These results suggest that single-site measurements of INPs can often represent surrounding areas and that cold-temperature INPs may show coherence over synoptic scales, providing observational constraints for representing INP variability in atmospheric models.

1CC.2

Ice Nucleation of Pristine and Aged Plastics in the Cirrus Cloud Regime. CAMILLE TEDDER, Gouri Prabhakar, Alexandria Johnson, *Purdue University*

Our atmosphere is a major pathway for the transport of plastic pollution. Atmospheric micro- and nanoplastics (AMnPs) have been detected in remote regions and can have lifetimes of days to weeks, allowing for aging within the atmosphere and ingestion into clouds. With the likelihood that plastic particulate concentrations will increase with time, it is necessary to understand the influence of AMnPs on cloud processes.

In this work, we focus on depositional ice nucleation on AMnPs in the cirrus cloud regime. To mimic the conditions of cirrus clouds in the laboratory, we use the Spectrometer for Ice Nucleation (SPIN). SPIN is a commercially available counterflow diffusion chamber capable of reaching -45°C and connected to a downstream optical particle counter that allows for the investigation of ice activation percentage, water vapor supersaturation, and ice nucleation onset temperatures of size-selected plastic particulates.

We focus our discussion on pristine and aged plastics previously found in the atmosphere, starting with polystyrene (PS) and expanding to polyethylene (PE), polypropylene (PP), and polyvinyl chloride (PVC). By comparing pristine and aged AMnPs in the deposition freezing regime, this work will test whether atmospheric processing alters a plastic's ability to nucleate ice under cirrus-relevant conditions and allow us to further understand the roles these particulates play in clouds and the atmosphere. To provide a more holistic understanding of AMnP impacts, our findings will also be compared with mineral dust standards including feldspar, illite, and kaolinite, to inform how they compete with naturally occurring ice nuclei for water vapor. These comparisons will help determine whether plastic pollution is merely transported through the atmosphere or alters the clouds within it, with implications for Earth's albedo and radiative balance.

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1CC.3

Wildfire-Derived Highly Viscous Organic Particles as Ice-Nucleating Particles. SWARUP CHINA, Gourihar Kulkarni, Nurun Nahar Lata, Amna Ijaz, Zezhen Cheng, Alla Zelenyuk, Lynn Mazzoleni, *Pacific Northwest National Laboratory*

Wildfires are among the largest sources of carbonaceous particles in the atmosphere. A substantial fraction of biomass-burning emissions consists of highly viscous, solid-state organic particles aka tar balls, which are especially abundant during the smoldering phase. However, the ice-nucleating potential of tar balls under mixed-phase and cirrus cloud conditions remains poorly constrained. Although tar balls have been produced in laboratory studies, their atmospheric complexity and variability make them difficult to reproduce under controlled conditions. The Pacific Northwest wildfire smoke episodes provided a unique opportunity to examine tar balls because they dominated the particle population, representing more than 90% of the observed particles. Here, we investigated the ice-nucleating ability of tar balls using both a PNNL continuous flow diffusion chamber (CFDC) and a custom-built ice nucleation cell coupled to an environmental scanning electron microscope (IN-ESEM). The CFDC probed ice formation under mixed-phase cloud-relevant conditions, while the IN-ESEM targeted cirrus cloud-relevant conditions. We also characterized the particles using single-particle analytical techniques and molecular-level composition analysis. Our results show that tar balls can initiate ice formation under both mixed-phase and cirrus cloud conditions. Based on these measurements, we derive a new tar ball ice-nucleation parameterization that can be implemented in future cloud-resolving models, particularly to improve representation of smoldering-phase wildfire smoke.

1CC.4

Molecular Chemical Characterization of Pollen Particles and Their Role in Ice Cloud Formation. ZIYING LEI, Rebecca Conner, Jack Smith, *University of Tennessee*

Pollen particles are important primary biological aerosols that can influence atmospheric chemistry, cloud formation, and climate. Although intact pollen grains are generally large, they can rupture under high humidity, precipitation, and strong wind to produce subpollen particles that are small enough to remain suspended in air and participate in cloud microphysical processes. These particles contain complex mixtures of proteins, polysaccharides, lipids, and other biological macromolecules that may affect their water uptake, cloud condensation nuclei activity, and ice nucleation ability. However, the molecular composition of pollen derived particles and its connection to cloud relevant properties remain poorly constrained. In this study, we used optical photothermal infrared spectroscopy to characterize the size, morphology, and functional group composition of pollen grains and subpollen particles from six dominant tree species in the southeastern United States: river birch, red maple, eastern white pine, black oak, American hophornbeam, and eastern hemlock. We also measured their immersion freezing temperatures to evaluate species dependent differences in ice nucleation ability. Immersion freezing was strongly species dependent, with river birch freezing at temperatures as warm as −11 °C and black oak freezing near −20 °C. Subpollen particles generally froze at lower temperatures than intact pollen grains, with the largest difference observed for river birch. These results demonstrate that both pollen species and particle type influence ice nucleation ability, highlighting the need to better constrain the chemical and microphysical properties of pollen derived aerosols in cloud relevant environments.

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1CC.5

Understanding the Vertical Variability of Arctic Ice Nucleating Particles and Its Correlations with Aerosol Properties from ARCSIX Airborne Measurements. BO CHEN, Russell Perkins, Kerri Pratt, Kevin Barry, Xingzhi Chen, Emily Costa, Andrew Holen, Camille Mavis, Ryan Patnaude, Vanessa Selimovic, Tiantian Zhu, Sonia Kreidenweis, Paul DeMott, *Colorado State University*

Arctic low-level clouds strongly modulate the surface energy budget and influence the pace of sea-ice change, yet the processes controlling their phase partitioning and persistence remain uncertain due to the sensitivity of cloud ice formation to the concentration, composition, and vertical distribution of ice-nucleating particles (INPs). Because INPs represent a very rare subset of the broader aerosol population, identifying the aerosol properties that control ambient INP concentration can be challenging. Here, we present airborne measurements of INPs and aerosols collected during the 2024 Arctic Radiation–Cloud–Aerosol–Surface Interaction eXperiment (ARCSIX). INPs were measured using off-line filter samples analyzed with the CSU Ice Spectrometer and real-time measurements from the CSU Continuous Flow Diffusion Chamber. Using these datasets, we examine how INP concentrations vary between samples collected above and below Arctic boundary-layer clouds, and how this variability relates to aerosol concentration, sizes, and composition. Normalizing INP concentrations by the number concentration or surface area of aerosols with diameters ≥100 nm does not reduce the sample-to-sample spread in INP concentrations. Instead, the spread increases in the resulting active fraction and active site density spectra. This result indicates that total aerosol loading and available particle surface area are poor predictors of INP variability in these samples. We further use online aerosol single-particle mass spectrometry and offline single-particle microspectroscopy, and elemental composition measurements to assess whether differences in INP activity are associated with particle type, chemical composition, and source region. FLEXPART source footprints are used to provide additional context for linking INP measurements to potential source regions.

1CC.6

Single-Particle Chemical Characteristics of Tropospheric Clouds and Aerosol from an Aircraft During CACTI 2018. AMNA IJAZ, Jerome Fast, Fan Mei, Mikhail Pekour, Beat Schmid, Israel Silber, Kaitlyn Suski, Jason Tomlinson, Adam Varble, Alla Zelenyuk, *Pacific Northwest National Laboratory*

Few field campaigns have combined detailed aerosol chemistry with coordinated cloud and meteorological observations over continental regions of the Southern Hemisphere. To help reduce this observational gap and to examine aerosol-cloud interactions in a convectively active, complex-terrain environment, extensive in situ and remote-sensing measurements were collected during the 2018 Cloud, Aerosol, and Complex Terrain Interactions (CACTI) campaign over the Sierras de Córdoba in central Argentina.

During the campaign, the chemical composition and size of individual atmospheric particles were characterized using a single-particle mass spectrometer (miniSPLAT) aboard the ARM Gulfstream-1 aircraft. Spanning altitudes up to 6200 m AMSL over the Sierras de Córdoba mountain range, measurements were conducted across 19 flights to capture particle characteristics of cloud droplet residuals (CDR), interstitial aerosol, and aerosol surrounding the cloud. Overall, 25 main particle types were identified across five broad chemical classes: sulfate-rich, organic-rich, biomass burning, nitrogen-rich, and inorganics, including soot, sea salt, and dust.

Campaign-wide analysis revealed systematic chemical partitioning among sampled particle populations. Sulfate-rich particles were the major contributor across all cloud regimes, regardless of particle types being sampled, while highly hygroscopic species (e.g., sea salt) and less-hygroscopic particles (e.g., soot and biomass burning particles) showed distinct preferential activation patterns that varied with supersaturation conditions. We will present a detailed analysis of several case studies that represent distinct air mass origins, cloud evolutionary stages, and sampling strategies. Vertical profiles from clear-sky flights revealed compositional transitions from biomass burning and sulfate dominance at lower altitudes to nitrogen-rich air masses characterized by pyridinium and organonitrates in the cold, dry upper troposphere.

Collectively, these observations demonstrate that cloud activation in complex terrain reflects a dynamic interplay of aerosol mixing state and localized supersaturation, with aerosol-cloud interactions exhibiting significant vertical and spatial heterogeneity across different meteorological conditions.

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1CC.7

Introducing the BNL Convection Cloud Chamber: A New Laboratory Platform for Controlled Aerosol–Cloud–Turbulence Studies. ARTHUR J. SEDLACEK, Fan Yang, Nour Kastoun, Raymond Shaw, Andrew McMahon, Connie-Rose Deane, Nathanial Speece-Moyer, Scott Smith, *Brookhaven National Laboratory*

Laboratory cloud chambers provide a powerful approach for isolating aerosol, cloud microphysical, and turbulent processes that are difficult to disentangle in the atmosphere. Here we introduce the newly developed Brookhaven National Laboratory (BNL) convection cloud chamber, a 1 m^3 laboratory testbed designed to support controlled investigations of aerosol-cloud interactions under well characterized thermodynamic and turbulent conditions. The chamber is distinguished by six independently temperature-controlled boundaries (top, bottom, and four sidewalls), enabling flexible control of thermal forcing, supersaturation, circulation structure, and wall driven gradients. This design provides a step increase in experimental complexity relative to canonical Rayleigh–Bénard convection chambers and creates new opportunities to investigate how spatially varying boundary conditions influence cloud formation, droplet populations, and aerosol processing.

Over the past year, performance testing has focused on quantifying chamber stability, thermal response, flow development, and the reproducibility of cloudy conditions under prescribed forcing. A central component of this evaluation has been intercomparison with large-eddy simulations using SAM-Chamber, providing a framework to assess both chamber behavior and model performance. Initial results demonstrate stable boundary-temperature control, reproducible thermodynamic gradients, organized large-scale circulation, and sustained cloud formation suitable for systematic aerosol and cloud experiments. For aerosol research, these tests establish the foundation for future studies of aerosol activation, cloud droplet growth, aerosol processing in turbulent clouds, secondary aerosol formation under humid conditions, ice nucleation, and instrument intercomparison under controlled cloudy environments.

The independently controlled thermal boundaries also make the chamber well suited for developing autonomous experimental workflows and testing AI-enabled control strategies for targeting specific cloud microphysical states. By combining precise environmental control, advanced aerosol and cloud diagnostics, and model–measurement integration, the BNL cloud chamber provides a new capability for investigating coupled aerosol–cloud–turbulence processes and generating benchmark datasets to improve process understanding, model parameterizations, and Earth system predictions

1RM.1 – INVITED

The Growing Impact of Wildfires on Air Quality in Latin America and the Caribbean: Observational Gaps and Recommendations for Air Quality Management. Admir Creso Targino, Graciela Binimelis de Raga, Lucia Caudillo-Plath, Sebastián Diez, Fernando Garcia-Menendez, Luis A. Ladino, LUPITA D. MONTOYA, Juan Pallotta, Blanca Estela Ríos Ramos, María Velázquez, *Universidad Nacional Autonoma de Mexico*

Climate change together with human-induced land-use and urban expansion are shifting wildfire frequency and intensity, leading to significant deterioration of air quality across Latin America and the Caribbean (LAC). Despite clear evidence of health and environmental impacts due to wildfire smoke, observational data for flagging such events remain scarce across LAC. Of the 33 LAC countries, only nine have reported operating continuous monitoring networks, with stations mostly concentrated in major urban centers, while coverage in smaller, less economically powerful urban areas is thinner, and rural or peri-urban regions are almost unmonitored. The lack of air quality data hinders our understanding of pollution dynamics and stalls policy mitigation efforts. A literature review over the past two decades revealed that Brazil, Mexico, Colombia, and Chile lead the region in the volume peer-reviewed publications on air quality and wildfires, reflecting clear discrepancies in scientific advancements across the region. Without sustained monitoring, it is challenging to identify emerging pollution patterns, which in turn hinders the implementation of effective air quality management policies for meeting the WHO guidelines. In this work, we examine the current state of air quality monitoring in LAC, evaluate alternative approaches to address underrepresented areas, and propose a roadmap to mitigate data scarcity. To fill observational gaps and populate underrepresented areas, we propose integrating a hybrid network of ground-based technologies, including low-cost sensors, satellite-based products, and high-precision remote sensing networks like AERONET.

In LAC, the central challenge is not only detecting wildfires pollution, but converting fragmented observations into timely estimates of smoke exposure and risk. Because plume transport, atmospheric ageing, and ground-level PM2.5 concentrations depend on coupled processes acting from local to continental scales, integrated monitoring frameworks are needed to connect in situ measurements, satellite retrievals, meteorological fields, and atmospheric modelling within a common analytical structure. Cooperation between LAC countries can potentially improve the management of fire-derived transboundary air pollution within their territories; however, such initiatives often face challenges due to limited financial and administrative capacity.

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1RM.2

Evaluating Long-Term Seasonal Variability of Aerosol Optical Properties in Colorado. ERIN K. BOEDICKER, Andre Bergeron, Gerardo Carrillo-Cardenas, Dominik Kulakowski, John Rogan, Elisabeth Andrews, Anna Gannet Hallar, *CIRES, NOAA*

The western U.S. climate has undergone significant changes over the past several decades marked by warming, drought, and declining snowpack. These environmental changes have led to enhanced wildfire activity, and can also lead to an increase in dust. These events introduce considerable uncertainty into both climate research and public health assessments. To gain a deeper understanding of western U.S. aerosol properties, we analyzed 13 years (2011-2024) of surface in-situ aerosol optical data from Storm Peak Laboratory (SPL) in northwestern Colorado, and 6 years (2019-2024) of surface in-situ aerosol optical data from Table Mountain (BOS) in central Colorado. The aerosol optical properties at both sites demonstrate a strong summer wildfire smoke signal (peaking in August) and evidence of springtime dust events. BOS exhibited higher aerosol loading than SPL, particularly during spring and winter, consistent with the proximity of BOS to urban sources and its lower elevation.

While the general patterns observed for SPL are consistent with a previous climatological analysis (covering the period 2011-2016) for the site, the longer SPL dataset used here shows that there has been a significant increase in extreme wildfire smoke events for 2017-2024 relative to 2011-2016. Both summer and fall exhibit statistically significant positive trends in the upper percentiles of scattering coefficient with trends of 10 ± 1% yr^{-1} at the 98th percentile in the summer and 2.4 ± 0.4 % yr^{-1} at the 96th percentile in the fall. Co-variability among some of the aerosol optical properties is used to further identify aerosol types and temporal patterns, demonstrating similarities between the two sites.

1RM.3

Global Timescales of Wet Deposition for Particles and Organic Gases. BEATRICE KYEREMATENG, Gabriel Isaacman-VanWertz, Christos Stamatis, *Virginia Tech*

Wet deposition is a critical removal pathway for gas-phase organic compounds from the atmosphere, yet quantifying its effect at a global scale remains inherently challenging. Precipitation is spatially heterogeneous and temporally sporadic with a frequency and duration that vary from region to region. In this presentation we use real-world measurements of precipitation to estimate the characteristic wet deposition timescale. Scavenging at measurement sites is modeled based on previously published parameterizations of removal of gases and particles supported by observational constraints that suggest timescale can be approximated simply as the amount of time to reach a cumulative amount of rain (~5 hours for soluble gases and ~15 hours for particles). Timescales of wet deposition across the United State are estimated from minute-by-minute measurements at more than 800 airports through the NOAA Automated Surface Observing System (ASOS) station network via Monte Carlo simulation, in which thousands of random starting points are sampled from the observed precipitation record and the elapsed time to accumulate sufficient rainfall is recorded and aggregated. These data are used to build a relationship between timescale and hourly probability of precipitation, which are found to be strongly correlated with timescales slightly longer than would be expected from probability of precipitation alone. This relationship is scaled globally through NASA's Integrated Multi-satellitE Retrievals for GPM (IMERG V07B), a satellite product with near-global spatial coverage. Precipitation data from both datasets are compared in terms of temporally averaged (e.g., hourly) binary rain/no-rain classifications and total rainfall. Timescales, probabilities, and total rainfall are estimated at ASOS stations spatially matched to the IMERG grid cells they are contained in, enabling direct location-controlled comparison. We demonstrate that total rainfall is well captured, with reasonable correlation and low bias, while correlations for probability of precipitation are somewhat more complex. By applying the timescale-probability relationship to IMERG probabilities we can map timescales for below-cloud scavenging worldwide, with direct implications for air quality modeling and the atmospheric organic carbon cycle.

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1RM.4

Integrating Ground-Based and NASA Remote Sensing Data to Investigate Atmospheric Aerosols and Carbon Cycling in Forested Ecosystems. JAMES HENRY, Thomas O'Halloran, Andrew Metcalf, *Clemson University*

Carbon cycling is a critical component of Earth's climate system, regulating the movement of carbon among environmental compartments, including the atmosphere, biosphere, soils, and surface waters. Accurate quantification of carbon flux at local and regional scales remains challenging because ground-based environmental monitoring stations are often separated by substantial distances, limiting the ability to capture fine-scale spatial and temporal variability. As a result, environmental scientists rely on remote sensing technologies to monitor ecosystem health, atmospheric conditions, and changes in ecological activity related to carbon exchange at the atmosphere-biosphere interface.

NASA offers a robust suite of satellite-based environmental monitoring products and instruments that quantify atmospheric and ecological parameters, including aerosol optical depth (AOD), atmospheric composition, and ecological productivity. While these satellite-derived observations are invaluable for advancing climate change and environmental health studies, their broad temporal and spatial resolution limits the characterization of carbon exchange and atmospheric composition at local and regional scales. These limitations are especially important where land cover, emissions sources, meteorology, and ecosystem activity vary over short distances.

This research focuses on generating ground-based measurements of aerosol optical depth, carbon flux, particulate matter, atmospheric composition, and local meteorological conditions across forested ecosystems in South Carolina. Instruments are deployed on a mobile environmental monitoring facility equipped with a 92-ft telescoping tower, allowing for simultaneous measurements at different heights above ground level. These measurements produce vertical profiles that characterize near-surface atmospheric structure, local weather conditions, aerosol loading, and carbon exchange with the surrounding environment. The primary goal of this research is to investigate how ground-based aerosols may interfere with satellite retrievals and estimates of atmospheric composition, thereby introducing uncertainties regarding our understanding of the carbon cycle. By integrating mobile, ground-based observations with satellite-derived products, this work aims to improve understanding of local environmental variability relevant to climate, air quality, and ecosystem health.

1RM.5

Air Quality in a Rural Anthracite Coal Region of Pennsylvania. DOUGLAS COLLINS, Dabrina Dutcher, Shaunna Barnhart, Brian King, Sean Koranteng, Iniyan Lourderaj, Calvin McGuire, Zoey Spang, Samuel Tuffour, *Bucknell University*

Air quality monitoring in rural regions is often under-represented in regulatory measurement networks. Rural communities face environmental hazards, although the associated pollutant profile often differs from those in more densely populated areas. In Pennsylvania, the anthracite coal region provides a compelling example: comm\unities were established around highly localized coal deposits beginning in the late 18th century and many remain densely populated despite long-term population and economic decline.

We are conducting an ongoing community-engaged air quality study in the Lower Anthracite Coal Region, focusing on Shamokin and Mt. Carmel, PA, both of which are classified as environmental justice communities by Pennsylvania EJScreen. Our monitoring network measures PM10, PM2.5, PM1, ozone, nitrogen oxides, carbon monoxide, particle number concentration, black carbon, and meteorological parameters using a combination of QuantAQ, AethLabs, and Gill MaxiMet instruments. One site also includes size- and time-resolved aerosol collection using a rotating DRUM impactor, along with high-volume air sampling for polycyclic aromatic hydrocarbon analysis.

This project asks whether the existing regulatory monitoring network adequately reflects the air quality experienced by residents in the Coal Region and whether localized air pollution may contribute to the region's elevated rates of asthma, cardiovascular disease, and cancer, as well as its low life expectancy. This presentation will describe the Coal Region context, preliminary sensor network measurements, and lessons learned from deploying and interpreting air quality measurements in rural communities. It will also discuss community engagement strategies to help residents understand air quality as an environmental health risk factor. Although the project is primarily designed to generate and share data that can support community action, it also serves as an important case study on the distinctive pollutant sources, exposure patterns, and environmental health challenges facing rural communities.

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1RM.6

Rural-Urban Air Quality Analysis and Hotspot Identification Using High Density, Statewide Sensor Network in West Bengal, India. SATHISH SWAMINATHAN, Alexander Berman, V. Faye McNeill, *Columbia University*

West Bengal, a state in India, located downstream of the Indo-Gangetic Plain, experiences severe air quality degradation from combined local and regional sources. Understanding spatiotemporal pollution dynamics across this densely populated state is crucial for designing effective air quality management strategies. We analyze four years of continuous monitoring data from a statewide network of 250+ sensor-based monitors deployed by the West Bengal Pollution Control Board to characterize pollution patterns and identify actionable hotspots.

Notably, rural and urban locations exhibit remarkably similar pollution profiles, fundamentally challenging existing urban-focused air quality management approaches, and highlighting the likely importance of regional influences. We use Independent Component Analysis(ICA), a machine learning algorithm for source decomposition which confirms this lack of strict urban-rural dichotomy, attributing approximately 68% of the state's air quality variance to regional effects rather than local emissions.

Air quality management in India under the National Clean Air Programme has focused on reduction of PM10 levels in urban areas. Multi-pollutant AQI analysis reveals a critical decoupling. While PM10 is the dominant pollutant at more than 80% of the sites, PM2.5 triggers more severe pollution episodes, particularly during winter. Seasonal patterns show the relative contribution of NO_2 to AQI increases during cleaner summer and monsoon months.

We developed a systematic hotspot classification framework categorizing sites into five operational classes, based on PM2.5 or PM10 exceedances or else 'Poor' AQI (>200 on the Indian NAQI scale). The classes range from Consistently Severe (locations exceeding the threshold for ≥30% of monitoring days), Repeated or Infrequent Off-Season Exceedance, Deteriorating, or Improving. Intra-city analysis in prominent cities with a dense monitoring network allows us to identify locality level variation and patterns. These findings demonstrate a need for air-shed based mitigation for most of the state along with targeted interventions at identified hotspots.

1RM.7

Unusually High Summertime Ammonium Nitrate in Particles over the San Joaquin Valley During the AEROMMA Project. ANN M. MIDDLEBROOK, Sarah Albertin, Alison Piasecki, Ilana Pollack, Joseph Roscioli, Emily Lill, Emily Fischer, John Crounse, Katherine Ball, Paul Wennberg, Charles Brock, Ming Lyu, Han N. Huynh, Adam Ahern, Amy P. Sullivan, Rodney J. Weber, Magesh K. Mohan, Sherry Luo, Michael Robinson, Andrew Rollins, Eleanor Waxman, Kristen Zuraski, Quazi Rasool, Nazrul Islam, Steven S. Brown, *NOAA Chemical Sciences Laboratory*

California's San Joaquin Valley (SJV) is classified as a serious nonattainment area due to exceeding the U. S. National Ambient Air Quality Standards for particulate matter less than 2.5 μm in diameter ($PM_{2.5}$). Typically, nonattainment occurs during wintertime stagnation events where low boundary layer heights trap pollutants and low temperatures drive partitioning of gas phase ammonia (NH_3) and nitric acid (HNO_3) to the particle phase. In contrast, the PM levels there are generally much lower in the summer unless the region is affected by exceptional events such as wildfires. During NOAA's Atmospheric Emissions and Reactions Observed from Megacities to Marine Areas (AEROMMA) airborne field project in the summer of 2023, an instrumented NASA DC8 aircraft sampled the SJV on June 26 and August 22. On the August 22 flight, mass concentrations of ammonium nitrate above 20 $\mu g/m^3$ were observed on the eastern side of the SJV between Fresno and Bakersfield. Relatively high summertime 24-hour PM2.5 mass concentrations of nitrate were also reported on that day by the Environmental Protection Agency's Chemical Speciation Network in Visalia and Bakersfield (4.74 $\mu g/m^3$ and 3.26 $\mu g/m^3$, respectively). The airborne observations were coincident with well-correlated increases in total (gas+particle) nitrate and total (gas+particle) ammonium, where the total ammonium was an order of magnitude higher than total nitrate. In the region, livestock operations are recognized as a significant source of NH_3. HNO_3, the other ammonium nitrate precursor gas, is produced in the atmosphere by oxidation of nitrogen oxides (NOx), which are considered to be emitted predominantly by vehicles or other combustion sources. However, in the rich, agricultural SJV, soils are also thought to be a prominent source of NOx. Soil moisture, pH, and temperature are some of the factors affecting atmospheric emissions of NH_3 and NOx from fertilized and non-fertilized soils. Southern California experienced a hurricane during the prior three days, with some of the storm's rainfall reaching the southeastern part of the SJV. This could have contributed to enhanced NOx and NH_3 emissions afterward. In addition, the mesoscale flow phenomenon called the "Fresno Eddy" possibly affected air recirculation, accumulating pollutants in the area from the prior night and intensifying the potential to form high $PM_{2.5}$ the next day. In this presentation, we will discuss the aircraft observations of this unusual event, including the partitioning of both HNO_3 and NH_3 into the particle phase despite warm summertime temperatures. We will also explore pathways for HNO_3 production from NOx, airmass back trajectories, and resulting variability across this agricultural basin.

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1UA.1

Using Large-Eddy Simulation to Interpret Aerosol Turbulent Flux Measurements in Complex Source Environments. ELLA IVANOVA, Sanghee Han, Lintong Cai, Nicholas Meskhidze, Markus Petters, *University of California, Riverside*

Aerosol flux measurements are a powerful tool to characterize land-atmosphere exchange and turbulent transport within the convective boundary layer. However, aerosol flux measurements typically lack independent external constraints, complicating their interpretation and validation. Here we show that large-eddy-simulation (LES) can serve as a physically consistent framework for interpreting aerosol flux observations across diverse source configurations. We present two complementary case studies. In the first, vertical profiles of coarse-mode particle number fluxes retrieved from Doppler lidar measurements during the TRACER campaign revealed a systematic increase in flux with height, followed by a decrease approaching the boundary layer top. LES simulations demonstrate that this vertical structure is indicative of spatially non-uniform surface emissions sampled within the lidar footprint - a finding that would be ambiguous from measurements alone.

In the second case, ultrafine particle fluxes from commercial aircraft landing operations were measured using a condensation particle counter and sonic anemometer deployed approximately 1-1.5 km east of the runway threshold. Fluxes were computed using both eddy covariance and a continuous wavelet transform (CWT) approach; the CWT method successfully resolved individual overpass plumes while suppressing sensitivity to the slowly varying background concentrations. Companion LES simulations with prescribed line sources confirmed that plume transport was intermittent and dominated by coherent turbulent structures rather than steady advection. It also demonstrated that the CWT directional approach recovers prescribed source fluxes in the LES and identifies dominant transport pathways. Together, these results establish LES as a quantitative interpretive constraint for aerosol flux measurements in complex source environments.

1UA.2

From Flames to Fryers: Characterization of Particle and Gas Emissions from Small-Scale Sources Using Drone- and Ground-Based Measurements. ABIGAIL MABEN, Karthick Mohan Kumar, Emilio Molina Rueda, John Flynn, Misa Soto, Clara McMullin, Gabriel Isaacman-VanWertz, Christopher Robertson, Tami Bond, John Volckens, Ellison Carter, Shantanu Jathar, *Colorado State University*

Small-scale emission sources, including prescribed fires, firefighter training burns, and food truck cooking operations, are increasing in number and prevalence in many regions. While emissions from these sources are reasonably well understood in laboratory settings, fewer observations exist under real-world conditions, where plume dynamics complicate sampling. Here, we present speciated emission factors (EFs) of particle and gas emissions from prescribed burns, vehicle and structural fires, and food truck cooking using drone- and ground-based field measurements with lower-cost monitoring systems. Continuous measurements included CO_2, CO, NO, $PM_{2.5}$, and BC, while integrated samples were collected on filters and sorbent tubes for offline analysis of $PM_{2.5}$ and BC mass, organic and elemental carbon, inorganic ions, trace metals, and speciated VOCs. Field measurements have been completed for prescribed broadcast and pile burns, and structural and vehicle fires. Drone-based sampling intercepted plumes directly downwind of combustion sources, while ground-based instruments measured background concentrations upwind. Additional measurements are planned for this summer at the Fort Collins Food Truck Rally, involving approximately 80 food trucks operating weekly over four months. Sampling will include direct duct measurements from individual trucks and drone-based measurements of the combined event plume to develop speciated EFs for food truck cooking operations. Results indicate substantial variability in EF profiles across source types and operating conditions. Vehicle burns exhibited elevated crustal and trace metal signatures, with Na, Si, Mg, Pb, and Fe EFs 5–30× higher than other sources, and unique detection of elements such as Zn. Broadcast burns were uniquely enriched in chlorine and potassium, with EFs approximately 70x and 40x higher, respectively. $PM_{2.5}$ EFs exhibited a dependence on modified combustion efficiency (MCE), with higher MCE values for open burning (broadcast and pile burns; 0.92–0.99) and lower MCE for oxygen-limited burns (structure burns; 0.55–0.95), while EFs remained broadly similar between these combustion conditions. These results improve source-resolved EF estimates and provide new insight for emissions inventories spanning wildland and urban sources.

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1UA.3

Transport and Deposition of Industrial Aerosol Plumes Within Coniferous and Broadleaf Forest Plantations in Suburban Areas. BORIS KRASOVITOV, Avi Levy, Itzhak Katra, *Ben-Gurion University of the Negev, Israel*

Numerous studies show that human exposure to carbon-based $PM_{2.5-10}$ from industrial sources increases the risk of exacerbating various bronchopulmonary and allergic diseases. Forest stands in suburban areas reduce aerosol pollution from industrial sources via plume dispersion and particle deposition on leaf surfaces, improving air quality in urban and suburban areas. In the present study, we propose a numerical model for Particle Deposition on a Forest Canopy (PDFC) with the average collection rate parameterized using a CFD model. Particle deposition onto vegetation elements is an integral component of the PDFC model, formulated for either coniferous needles or broadleaf foliage. The turbulent momentum and mass transfer in and above the forest canopy are described by a gradient turbulent transfer model, with a modified Blackadar model for turbulent viscosity within the canopy. The results are analyzed under different meteorological conditions and atmospheric stability regimes representative of the wide range of boundary-layer states. The performed numerical simulations showed higher particle collection efficiency in coniferous canopies compared to broadleaf stands. Numerical results further showed that the highest collection efficiency occurs under slightly unstable or neutral atmospheric conditions, when turbulent flow is sufficient to penetrate the canopy without inducing strong upward particle transport. In a highly unstable atmosphere, deposition is weakened by active vertical mixing. Under stable stratification, the efficiency remains significant. At the same time, in a stable atmosphere, the forest's zone of influence is limited. Thus, forest plantations are most effective in reducing air pollutants under daytime convective conditions. The results of this study highlight the importance of forest plantations in controlling air pollution from industrial sources in adjacent urban areas.

1UA.4

High Time Resolution of Toxic Metals Monitoring in California's Central and Imperial Valleys. EHSAN GOFTARI, Jose Carias, London Fulford, Shosha Capps, Brandon Louie, Jonathan London, Hanyang Li, *San Diego State University*

Communities located in California's Imperial and Central Valleys experience disproportionate exposure to air pollution and associated health risks. These predominantly Latino, low-income regions are impacted by industrial, agricultural, and natural emission sources that release toxic metals linked to respiratory and cardiovascular diseases. To address this environmental injustice, the Toxic Metals Monitoring Regional Network (ToMMoRW) was established through a collaboration between Comité Cívico del Valle (CCV) and research institutions at the University of California, Davis (UCD) and San Diego State University (SDSU). This project integrates low-cost Toxic-metal Aerosol Real-Time Analyzers (TARTAs) into CCV's Identifying Violations Affecting Neighborhoods (IVAN) network to enable community-based monitoring.

A key component of ToMMoRW is capacity building through a three-day hands-on training workshop held in September 2025, where community technicians learned to assemble, operate, and maintain TARTA instruments. The training combined lectures, demonstrations, and laboratory sessions, and pre- and post-workshop surveys were conducted to evaluate changes in technical knowledge and confidence.

Following the training, 12 TARTAs were deployed across California's Imperial and Central Valleys beginning in March 2026. At Imperial Valley sites, average elemental concentrations (ng/m^3) were Al (155.4), Cu (12.4), Fe (1177.7), Mg (100.6), Li (27.8), Mn (30.1), and Zn (338.1). The urban Brawley site exhibited the highest Zn concentrations, suggesting traffic-related emissions, while elevated Li at Bombay Beach indicates potential influence from nearby lithium mining activities.

These efforts demonstrate the feasibility of community-driven toxic metal monitoring and highlight the potential for combining low-cost technologies with local engagement to support source identification and environmental health advocacy.

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1UA.5

Interannual Variability of Secondary Organic Carbon Driven by Seasonal Shifts in Formation Regimes in Southern Taiwan.

JUN-FA YE, Chih-Yu Chan, Jian-Xian Wu, Shi-Ya Tang, Li-Hao Young, Tse-Lun Chen, Si-Chee Tsay, Neng-Huei Lin, Ta-Chih Hsiao, *National Taiwan University, Taiwan*

Secondary organic aerosol (SOA) formation in urban environments is often attributed to volatile organic precursors and atmospheric oxidation capacity. However, field observations often show that similar oxidation conditions can lead to markedly different organic aerosol responses, suggesting that additional thermodynamic and multiphase processes may modulate SOA production. Capturing these coupled effects requires observations with sufficient temporal resolution and analytical tools capable of resolving nonlinear interactions. This study uses high-time-resolution measurements from Nanzi, Kaohsiung, a mixed urban-industrial site in southern Taiwan, to investigate secondary organic carbon (SOC) variability during 2024-2025. The dataset includes carbonaceous aerosols, trace gases, VOCs, aerosol liquid water content, aerosol pH, and meteorological parameters, providing an opportunity to examine SOC formation during and beyond the Airborne and Satellite Investigation of Asian Air Quality/Kao-Ping Experiment (ASIA-AQ/ KPEx) intensive observation period. Rather than interpreting SOC variability through individual indicators alone, we applied an interpretable machine learning framework combining XGBoost and SHapley Additive exPlanations (SHAP). This approach was used to evaluate how chemical, thermodynamic, and meteorological factors jointly influence SOC under different seasonal conditions, with particular attention to early spring when a pronounced interannual contrast was observed. Conventional indicators suggested that early spring 2024 was characterized by weaker ventilation and greater aromatic SOA formation potential. Explainable machine learning further indicated that elevated SOC during the ASIA-AQ/KPEx period was not simply a matter of "more precursors" or "stronger oxidation," but reflected a shift in the chemical environment controlling SOA formation. Specifically, the campaign period appeared to capture a more acidity-sensitive regime, whereas the corresponding period in 2025 showed a more oxidation-centered structure. By linking continuous aerosol measurements, VOC information, aerosol thermodynamics, and explainable machine learning, this study demonstrates how high-time-resolution monitoring can identify hidden formation regimes and clarify when urban SOA formation shifts from oxidation-driven processes toward multiphase or acidity-sensitive pathways.

1UA.6

Evaluating the Contribution of the Polluted Tijuana River on Regional Air Quality Using Machine Learning and LC-MS/MS Analysis.

LEILA EL MASRI, Tobie Bloom, Sonya Patel, Emma Buerk, William Porter, Kimberly Prather, *University of California San Diego*

In summer 2024, historically high discharges of municipal and industrial wastewater were discharged into the Tijuana River (TR) in Southern California. Increased river flow enhanced turbulence at the Saturn Blvd. river crossing (SBC), enhancing river spray aerosol production and volatilization of gas-phase contaminants. A simultaneous heatwave and suppressed marine boundary layer favored pollutant accumulation. A diversion of pollutants to a nearby treatment facility provided a natural experiment to isolate the TR's impact on air quality.

Paired aerosol and water samples were collected at the TR, a coastal site near the river mouth, and Scripps Institution of Oceanography Pier to evaluate the TR's contribution to regional air pollution. Offline analysis of aqueous and aerosol filter extracts via Orbitrap LC–MS/MS, coupled with four machine learning models: random forest, support vector machine, partial least squares discriminant analysis, and linear discriminant analysis, resolved distinct spatial and temporal chemical signatures. Aerosolized compounds near the TR spanned diverse classes, including pharmaceuticals, illicit drugs, metabolites, pesticides, and industrial chemicals, with compositional shifts observed following the flow diversion. Key compounds detected in the polluted air near the TR include terbutryn, phenacetin, tapentadol, and an MDMA analog. Airborne pollutant concentrations were highest near the TR and decreased by up to 80 percent following the diversion event, indicating a strong link between river pollution and airborne contaminant levels.

These findings highlight the TR as a significant, dynamic source of airborne pollutants. These results underscore disproportionate exposure risks for communities near the SBC and the TR, particularly under high-flow, low-dilution conditions.

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1UA.7

Wintertime Urban-Suburban Comparison of Aerosol Composition, Aging, and New Year Plumes in Houston, TX.

FANGZHOU GUO, Xiangxinyue Meng, Anandi Williams, Jiayun Zhao, Miska Olin, Eugenia Velasco-Cunningham, Sergio Alvarez, Sascha Usenko, Robert Griffin, Roya Bahreini, Sean Raffuse, Ann M. Dillner, Armistead G. Russell, Nga Lee Ng, Yue Zhang, James Flynn, *Aerodyne Research, Inc.*

Houston, TX, as a large industrial city on the Gulf of Mexico, experiences complex wintertime aerosol variability driven by urban emissions, industrial plumes, coastal influences, episodic biomass burning and fireworks activity, and secondary formation. However, wintertime aerosol mass spectrometry observations in the Houston metropolitan region remain limited. From December 19, 2025, to January 3, 2026, we conducted an intercomparison of aerosol composition and size distributions between an urban site at the University of Houston Energy Research Park (ERP) and the suburban ASCENT Houston site in Liberty, TX. The urban site hosted an HR-ToF-AMS and a SEMS in the TAMU Mobile Laboratory, while the suburban site operated its established suite of a ToF-ACSM, SMPS, Xact, and AE33.

On average, organics (AMS: 2.00±2.43 μg/m^3, 58.5%; ACSM: 5.92±6.85 μg/m^3, 59.3%) and sulfate (AMS: 0.88±0.92 μg/m^3, 25.8%; ACSM: 2.38±2.20 μg/m^3, 23.8%) dominated the $PM_{2.5}$ composition at both sites. Elemental ratios (AMS: O/C = 0.44, H/C = 1.65; ACSM: O/C = 0.81, H/C = 1.49) and preliminary PMF results (AMS: 29% POA; ACSM: 17% POA) suggested a stronger influence of fresher semi-volatile sources at ERP and more processed, transported aerosol at Liberty. Back-trajectory clustering at both sites identified consistent Oceanic, Northern Continental, and Northwesterly airmass scenarios. The largest ACSM-to-AMS discrepancies occurred during the Oceanic period, when Liberty was downwind of the urban area and the Houston Ship Channel. At Liberty, a broad plume on Dec. 31 showed enhanced organics, elevated eBC, biomass-burning influence in ACSM f_{60}, and moderate particle growth, consistent with a regionally transported, aging plume. In contrast, the Jan. 1 event showed clear fireworks influence, supported by Xact elements (K, Cl, Ba, Cu, and Sr) and more rapid particle growth. Overall, the suburban site exhibited higher mass loadings despite similar bulk fractional composition.

1UG.1 – INVITED

Bad Air from Big and Small Cars Leads to Bad Hearts and Brains.

ANTHONY S. WEXLER, *University of California, Davis*

Big and small cars send bad stuff into the air that is not good to breathe. This talk will help push us and others to clean up the bad air from cars so that we, our parents, and our children can enjoy a better life.

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1UG.2

Finding 'What It Is Made Of' and 'How It Might Grow' for the Smallest Bits That Are in the Air. COLLEEN MILLER, Paulus Bauer, Véronique Perraud, James Smith, *University of California, Irvine*

In air, clouds start so small we cannot even see them. When they are that small, there are many questions on how they grow and what they are made of. Many of the smallest, smallest parts, before they even become clouds, are groups of things that will share a single -Hand- (without the and) between them. In this work we looked at the smallest bits that are in the air, looking at stuff that is made from two parts. The first comes from water-life-form-air that changes with sun as well as human bad air. This groups with the second part that comes from air from human and animal events. Using our 'what-is-it-made-of' machine we found the 'made of' for different sizes of groups. We also used a machine to slam high power into the groups to learn how they may or may not break. This let us guess at ways these groups will come together during the time to grow to one day form clouds.

1UG.4

Smoke Inside of the Tiny Air Spaces in Walls. RACHEL HURLEY, *Worcester Polytechnic Institute*

During fires, smoke gets inside. Walls, wood, and floors, get full of smoke. After fires, smoke that is inside of the walls (and wood and floors) makes us sick. Then, the walls hold on to and let go of that smoke for a very long time into the inside air. And that can make us sick. How does smoke make us sick? Two things (1) the largest total of smoke that you breathe, and (2) for how long you breathe it for. There are set points for how much smoke is bad for you, because smoke has bad small parts inside of it that we know make us very sick. We do not hope to breathe above the set points and we need to find how to make this not happen.

Our work cares about what parts of the walls in the home make the smoke stay for a long time. First, walls are full of air spaces. The smoke and bad small parts inside of the smoke move into the wall air space and stick inside. But how does the air space look inside of the walls? Is it small, tight, open, closed? This is important for how well the smoke moves into and stays in the walls. Also, what about the smoke makes it want to stick inside of the walls, or to the top? The small bad parts of the smoke are not like one another, and this makes them go into or on top of the walls in their own way. And we know that walls have paint and other things on top. Like the walls, the paints are not like each other, and these also change how the smoke moves into the walls. Maybe, the paint makes the walls easier to clean from smoke. Or changes what tiny parts of smoke we can clean. Paint, the walls, and bad small parts in smoke all matter.

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1UG.5

Too Wet, Too Dry, or Just Right for Brown Smoke? PRAKRITI SINGH, Erin Bowey, Malsha Amugoda, Pedro De Allende, James F. Davies, Paula K. Hudson, *University of California, Riverside*

Forest fires send tiny bits into the air. Some of these bits are brown and can take in light from the sun, which can make the air warmer and change how long they stay around. To learn more, I make my own tiny drops using two things that grow brown when they are put together. These drops are held in the air one at a time in our set-up, so they do not touch anything. I then change how wet or dry the air is around each drop and watch how much light the drop takes in. I found that these drops keep getting darker for a long time, even after three weeks! But how brown they get changes with the water in the air. If the air is very wet, the drops do not take in much light. If the air is very dry, they also stay light-colored, because the stuff inside is too thick to move around easily. But when there is not too much or not too little water, drops get most brown. When a drop is dried out and then made wet again, it becomes darker than it was before. It does not go back to how it was. In later work, I will put sun-like light on the drops and watch how the stuff inside these drops changes. This will help us see if the brown bits get even darker or if the light makes the color go away.

1UG.6

Figuring Out What the Small Pieces That Come off of Cars Are Made of and How to Find Them near Busy Roads. DHIVYA MANICKAM, Samuel La Salle, Madeline Cooke, Lisa Wingen, Adam Thomas, Berenice Rojas, Véronique Perraud, Celia Faiola, Barbara Finlayson-Pitts, James Smith, *University of California, Irvine*

When you want your car to stop moving, flat pieces get pushed together and spin until it slows down. This spinning causes small bits break off into the air, and the flat pieces wear down over time. It is important to study these bits in the air because it can hurt people when they breathe, especially in cities where there are lots of people and lots of cars making these bits.

To study these small bits, we used an Air Check Stuff Machine that can tell us about what kinds of bits are in the air. First, a large box was built inside where we could make car stopping bits again and again while changing how hard the flat pieces stopped and tried two kinds of stopping parts that lots of cars use today. The Air Check Stuff Machine saw special signs that helped us know the bits have things that can make people feel bad.

The Air Check Stuff Machine was then taken to a big road with many cars and trucks. We looked at the air over many days and used a computer to break up the information into five different kinds of bits. One kind of small bits had special signs just like the bits made in the inside box. There were a lot of these special bits when cars on the busy road were slowing down and getting faster. In all, about one out of every eight small bits in the air near the road were these special kind. As cars move to using hard box power instead of smelly water power, it will become more and more important to follow these bits in the air.

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1UG.7

How Light and Cleaning Can Change the Air We Breathe.
ESTHER OZURUOHA, Sofie Schwink, Ethan Richter, Marina Vance, *University of Colorado Boulder*

We spend much of our time inside, so the air inside matters, and this air can change when we clean. When we use cleaning stuff, some things from it can come together with other things in the air, and so, tiny bits can form. These tiny bits are too small for us to see, but we can still breathe them in.

Since light is also part of many places inside, I wanted to know if light changes how many tiny bits form, so I tried different kinds of light, such as room light, sun light, strong clean light, and no light.

From this work, I found that light matters because some light made more tiny bits form, while other light made less. In all, this work helps us learn how cleaning and light can change the air inside, and in the long run, it can also help us make better choices for the air we breathe

1UG.8

Does Smoke from Fires in Forests Hurt Humans in a Different Way than Smoke from Plastics?
BRADLEY H. ISENOR, Arthur W. H. Chan, *University of Toronto*

Fires are happening across the Earth more because humans are making the Earth warmer. Because there are more fires, there is more smoke. Smoke is bad because it is made up of small balls in the air that humans should not breathe. When fires burn different things, they burn in different ways, making the smoke different, and changing the how much the smoke hurts. While fires burning forest and grass areas happen the most, fires happening where people live are also important and are happening more with time. These fires where people live are interesting because they burn human-made things, like plastic, that are very different from grass and trees. For people to understand how bad smoke is from fires, we need to understand how much the smoke hurts people when it comes from burning things from forest/grass areas and areas where humans live. Here we show how the smoke from burning forest/grass area things hurts people different to the smoke from plastics. This helps people understand how bad the smoke they breathe is.

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1UG.9

New Things Form When Sun Hits Tiny Stuff in Air Water.
ANGELINA PETERSEN, Alair Wong, Tran Nguyen, *University of California, Davis*

The earth's air has tiny bits of stuff that can come from dust, smoke from power-making buildings, or even from an animal's number two. Sometimes the stuff from animals and power buildings join together in the air to make a new hard rock-like bit. When there is lots of water in the air, the water sticks to it, making a tiny circle around it called air water. The tiny rock-like bit and the circle of water are like friends holding hands together, yet people usually only study the water by itself. Most people think that this tiny bit inside the water just sits in the air before falling down onto the ground. However, the sun hits the tiny bits of hard stuff in the air water and new things form very fast! Today we have a lot of fires that create smoke and we wanted to understand if the smoke can even make the new things form even faster. We took water in a cup, added the same tiny rock-like stuff along with smoke to make it be like air water, and placed it on top of the roof to get light. Every two hours, we took some of the air water and put it into a machine that told us how many new things were made. Turns out, there is a lot of new things, especially when smoke is added. These new things can make the earth warmer, hurt people when they breathe, make more clouds and even make brown color! This will help us understand the future air in our world and guess what will happen as we have more fires.

1UG.10

Guess What Kinds of Tiny Stuff Is in Space Air? MARIT MEYER, *Amentum/NASA*

If you ride in a strong car with a point on it that goes up, up, up and far, far, far away from our land, you get to space. People live up there inside a house that is like big cans full of air stuck together. There is no air outside so they stay inside the cans almost all the time. But people always make small pieces of stuff that makes the inside air less clean. So the air needs to be cleaned over and over again by these boxes so that people can breathe well. I like to study the stuff that goes into these boxes. I like to figure out where it came from. I see pieces of stuff from food. I see long little things from clothes. I see stuff that comes from people, like parts of their skin, and even pieces of the stuff they put on their body to smell good. I see stuff that no one knows what it came from but it is fun to try and guess. I will tell you more about these tiny pieces of stuff in space air!

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2AC.2

Mechanistic Insights Into the Photooxidation of Dimethyl Diselenide (DMDSe): Comparisons with Dimethyl Disulfide (DMDS) and Dimethyl Selenide (DMSe). MICHAEL LUM, Linhui Tian, Erin Bowey, Roya Bahreini, Ying-Hsuan Lin, *University of California, Riverside*

Dimethyl selenide (DMSe) and dimethyl diselenide (DMDSe) are volatile organic compounds (VOCs) emitted from both marine and terrestrial ecosystems. Although several studies have investigated the oxidation of their sulfur-containing chemical analogs, the gas-phase daytime oxidation pathways of these selenium-containing compounds have yet to be fully understood. Utilizing an environmental batch chamber to simulate low-NO_x, OH-initiated oxidation of DMDSe, the time series of gas-phase products were characterized using an iodide chemical ionization mass spectrometer and compared to products previously identified in the DMDS and DMSe oxidation reactions. Several selenium-containing compounds previously observed in the DMSe system were detected, including selenium dioxide (SeO_2), methaneselenonic acid (CH_4SeO_3), and selenous acid (H_2SeO_3), as expected based on comparisons with the analogous dimethyl sulfide/DMDS systems. Additionally, $C_2H_4O_2Se_2$ was detected during the early stages of oxidation, implying a similar initial oxidation step for DMDSe compared to DMDS. However, the presence of additional selenium-containing species, such as C_2HO_3Se and $C_3H_3O_4Se$, implies that while the initial oxidation step may be similar to that of DMDS, the later-generation products follow oxidation pathways unique to the selenium-containing system. This study aims to provide molecular-level insights into the products formed uniquely during DMDSe oxidation compared to DMDS and DMSe, further characterizing the role of selenium in the atmospheric biogeochemical cycle.

2AC.4

The Data Infrastructure of the Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT): From the Instruments to You. SEAN RAFFUSE, Veronica Scott, Rudi DeMarco, Brian Trout, Trinidad Padilla, Xiaoya Cheng, Roya Bahreini, Ann M. Dillner, Armistead G. Russell, Richard Flagan, James Flynn, Drew Gentner, Robert Griffin, Lelia Hawkins, Jose-Luis Jimenez, Jingqiu Mao, Shane Murphy, Albert Presto, Allen Robinson, John Seinfeld, Jason Surratt, Joel Thornton, Nga Lee Ng, Bob Dattore, *University of California, Davis*

The Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT) is a new comprehensive, high time-resolution, long-term monitoring network in the U.S. for characterization of aerosol chemical composition and physical properties. ASCENT consists of a network of 12 advanced aerosol measurement sites across the country, leveraging existing monitoring locations and facilities. Each site is equipped with a suite of advanced aerosol instrumentation, including an Aerosol Chemical Speciation Monitor (ACSM, non-refractory aerosols, $PM_{2.5}$), an Xact (trace metals, $PM_{2.5}$), an Aethalometer (aerosol light absorption, black and brown carbon, $PM_{2.5}$), and a Scanning Mobility Particle Sizer (SMPS, aerosol number size distribution and concentration, PM_1). All ASCENT sites were operational and sampling as of May 2024. The high time-resolution, speciated aerosol measurements at ASCENT sites have provided new insights into the characteristics of aerosols in diverse geographical regions and facilitated collaborative studies across academia, industry, and government. A comprehensive data infrastructure was developed to marshal ASCENT data in real time and public access to these data began earlier this year. We will provide an overview of the data infrastructure and explain how to access and interpret the available data levels, including both near real time preliminary data and annual validated data.

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2AC.5

Urban-Rural Gradients in Aerosol Liquid Water and pH During the CoURAGE Campaign. AMIR BABAEI-GHAREHBAGH, Jemma Przybocki, Marissa Cuevas, Isaiah Smith, Maria A. Zawadowicz, Akua A. Asa-Awuku, Benjamin A. Nault, Peter F. DeCarlo, Christopher Hennigan, *University of Maryland, Baltimore County*

Aerosol liquid water content (ALWC) and pH are closely linked in atmospheric particles through meteorology and particle composition. In this study, we characterize urban–rural gradients in ALWC and aerosol pH near Baltimore, MD during the 2025 Coastal-Urban-Rural Atmospheric Gradient Experiment (CoURAGE) campaign. Simultaneous measurements at paired urban and rural sites ~50 km apart show a persistent urban heat island (UHI), with higher temperature and lower relative humidity in the urban environment. Average differences of 1–3 °C and 8–15% RH were observed, with episodic enhancements exceeding 8°C and 30% RH. Aerosol pH at both sites predominantly ranged from 0 to 3.5, indicating highly acidic particles. NH_3 concentrations were weakly correlated between the two sites; but showed distinct urban and rural sources that impacted pH differently. Increasing temperature was associated with reduced ALWC and NH_3 partitioning shifted towards the gas phase, both acting to enhance aerosol acidity (lower pH). In addition, larger urban–rural differences in ALWC were observed under stronger temperature gradients. Urban-rural differences in aerosol pH were most impacted by the RH gradient, followed by differences in NH_3. These results demonstrate that UHI-driven thermodynamic effects play a key role in regulating aerosol acidity and multiphase partitioning near urban environments.

2AC.6

Secondary Aerosol Formation and Growth During Heatwave. YIXIN LI, Sarah D. Brooks, Renyi Zhang, *Texas A&M University*

Global warming leads to more frequent and intense heatwaves. The most recent decade shows the highest average temperature with a significant trend of increasing heatwaves, and 2024 is the hottest year on record with the average global temperature for the first time exceeding 1.5°C above its preindustrial level. Climate change alters emissions and atmospheric chemistry, inevitably impacting the gas-to-particle conversion and aerosol properties. We conducted a comprehensive field campaign to study atmospheric chemistry during heatwave (AC-HEAT) by deploying a suite of state-of-the-art instruments to measure trace gases and nanoparticles. The AC-HEAT field campaign was conducted in August 2024 on a rooftop that is ~50 m above the ground (~150 m above the sea level) on the campus of Texas A&M University in College Station, Texas. This site is located at the center of the Texas Triangle comprising Houston, Austin-San Antonio, and Dallas-Fort Worth, with regional emissions including anthropogenic species from the urban centers and biogenic species such isoprene from surrounding oak trees and monoterpenes from pine trees. In this presentation, we will present measurements of aerosol properties, including size and number distributions, chemical compositions, density, and hygroscopicity, to elucidate the underlying chemical mechanisms leading to aerosol nucleation and growth.

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2AC.7

Nonlinear Relationship Between PM2.5 Reduction and Surface Ozone Changes in Northeast Asia. JONG-MIN KIM, Yu-Jin Jo, Hyo-Jung Lee, Cheol-Hee Kim, *Pusan National University*

$PM_{2.5}$ has declined substantially across major cities in Northeast Asia in recent years, whereas surface ozone (O_3) has remained unchanged or increased in many urban regions, suggesting that $PM_{2.5}$ mitigation does not necessarily produce co-benefits for O_3 reduction. This study investigates the nonlinear relationship between $PM_{2.5}$ and O_3 over Beijing, Shanghai, and Seoul using ground-based observations during the summers of 2015–2022. The observational analysis reveals regionally distinct nonlinear behavior in the $PM_{2.5}$–O_3 relationship, suggesting that the atmospheric response to aerosol reduction depends strongly on local atmospheric chemical conditions. To better understand the aerosol chemistry underlying these observed changes, we performed WRF-Chem simulations using the t1_mozcart mechanism, which explicitly includes HO_2 aerosol uptake, and compared a control simulation with a sensitivity simulation in which HO_2 uptake was disabled (noUPTK). For high-PM episodes in Beijing during June 2016 and June 2021, the noUPTK experiment showed increases in HO_2, O_3, and O_x, along with changes in the partitioning of oxidized nitrogen species. These responses became stronger with increasing $PM_{2.5}$, indicating that aerosol-mediated HO_2 uptake acts as an effective sink of HO_2 and suppresses O_3 production under polluted conditions. The sensitivity was stronger and extended over a wider $PM_{2.5}$ range in 2016 than in 2021. Overall, the results demonstrate that heterogeneous HO_2 uptake on aerosols is an important process linking $PM_{2.5}$ and O_3 in polluted urban environments of Northeast Asia. These findings highlight the need for region-specific air quality management strategies that consider both aerosol–radical interactions and evolving VOC–NOx sensitivity.

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2AC.8

Occurrence and Characterization of PFAS in Atmospheric PM2.5 Using Target and Non-Target Analysis. SUJUNG HAN, Taeyeon Kim, Hyejin Shin, Kyung-Duk Zoh, Kwon Ho Jeon, Seung-Muk Yi, *Seoul National University*

Per- and polyfluoroalkyl substances (PFAS) are widely used in industrial and consumer products due to their heat resistance, which originates from strong C-F bonds, and water-repellent properties. However, they pose significant health risks, including neurotoxicity, immunotoxicity, and carcinogenicity, while remaining highly persistent in the environment. PFAS can undergo long-range atmospheric transport through volatilization of precursor compounds and adsorption to airborne particles, followed by deposition via rain, snow, and dry fallout, leading to widespread contamination even in remote environments. This study focused on PFAS monitoring in $PM_{2.5}$ samples and established a comprehensive analytical methodology comprising two main approaches: target quantitative analysis and suspect/non-target screening. For target analysis, 25 ionic PFAS species were analyzed using liquid chromatography-tandem mass spectrometry (LC-MS/MS) following a pre-treatment sonication extraction and solid-phase extraction (SPE) purification with an ENVI-Carb cartridge. Simultaneously, liquid chromatography-quadrupole-time-of-flight high-resolution mass spectrometry (LC-Q-ToF) was employed for suspect/non-target screening to identify emerging PFAS compounds that lack standard reference materials. Sonication followed by SPE purification achieved 71.7-126.1% accuracy and 79.8-122.65% internal standard recovery. The monitoring results showed that the total average PFAS concentration in PM2.5 was 3.00 pg/m^3, with individual samples ranging from 0.80 to 7.00 pg/m^3. Predominant compounds detected included perfluorohexanoic acid (PFHxA) and perfluorooctanoic acid (PFOA). Long-chain PFASs were dominant in the $PM_{2.5}$ samples compared to short-chain PFASs because of the hydrophobicity of long-chain PFASs. Furthermore, suspect screening elucidated unknown contaminants, such as 3:3 FTCA and PFMPA, highlighting the diversity of atmospheric PFAS beyond the traditionally monitored species. The research points out the need to monitor $PM_{2.5}$ as a direct pathway for human inhalation exposure.

Acknowledgment
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2AC.9

Molecular Evolution and Nitrosalicylic-Acid-Dominated Organic Aerosol Formation in an Urban-Coastal Environment.

MEGHA ANAND, Abhishek Chakraborty, *Indian Institute of Technology Bombay*

Molecular-level characterisation of organic aerosol (OA) is needed to understand secondary formation, nitrogen incorporation, volatility changes, and brown-carbon-related chemistry in polluted urban air. Here, wintertime $PM_{2.5}$ over Powai, Mumbai, was investigated using GC-Orbitrap-HRMS. The site represents an urban-coastal setting where traffic and combustion emissions interact with vegetation-derived precursors under humid aerosol conditions.

Non-target GC-Orbitrap-HRMS showed strong day–night differences in OA composition. Unique compounds increased from 1261 during daytime to 1945 at night, with the largest structural-class increase observed for heterocyclic compounds (157 to 331). Night-specific compounds were enriched in CHO and CHON classes, while DBE increased from 4.0 to 4.8, modified aromaticity index from 0.26 to 0.30, carbon oxidation state became less negative from −1.8 to −1.4, and $\log_{10}C^*$ decreased from 2.7 to 2.2. Mean ∑NAC was approximately 610 ng m^{-3}, with mean NAC/OC of ~2%. Nitrosalicylic-acid-type compounds dominated the targeted NAC pool, contributing ~64% of ∑NAC, indicating OA is strongly influenced by nitrogenated aromatic acids rather than only nitrophenol or nitrocatechol type chromophores. ∑NAC was strongly associated with biogenic SOA tracers and levoglucosan, and moderately associated with nitrate, suggesting coupled biogenic oxidation, combustion-related precursor input, and reactive nitrogen chemistry. These relationships are consistent with anthropogenic–biogenic processing involving RO_2–NO_x chemistry, NO_2/NO_3^-mediated aromatic nitration, and gas-to-particle partitioning of multifunctional organics. ALWC and aerosol pH provide an additional control by regulating nitrate partitioning, aqueous processing, haze formation, and the persistence of brown-carbon-related chromophores. The study has broader relevance for tropical and subtropical megacities where high NO_x, vegetation-derived VOCs, and humid aerosol conditions coexist.

Overall, Powai winter OA is characterised by nighttime enrichment of oxygenated, nitrogen-containing, lower-volatility molecules and a nitrosalicylic-acid-dominated NAC–BVOC combustion molecular mode. These findings have implications for $PM_{2.5}$ exposure, light absorption, radiative forcing, and emission-control strategies targeting both anthropogenic emissions and their interaction with biogenic precursors.

2AC.10

Using Tryptophan as an Indicator of PH in Bioaerosol Particle Fluorescence for Temporal Resolution of Aerosol Chemistry.

HUNTER RICHARDS, Zhenyu Ma, Allen E. Haddrell, Herek L. Clack, *University of Michigan*

While the role of pH in respiratory virus inactivation has recently been discussed, measuring the change in pH of aerosols carried in the rapidly changing dynamics of exhaled breath is required to better connect this relationship to transmission of human respiratory diseases.

Tryptophan, a pH-sensitive fluorophore, can serve as a proxy to monitor in situ the change in pH of bioaerosols using a wideband integrated bioaerosol sensor (WIBS, Droplet Measurement Technologies) to analyze fluorescence intensity. WIBS measures bioaerosol fluorescence intensity by using a Xenon flash lamp to excite tryptophan at its known excitation wavelength of 280 nm, which produces fluorescent emission at 310-400 nm wavelength. An exploration of the effect of relevant environmental parameters, such as relative humidity and CO_2 concentrations, on aerosol pH provides insights into the impact on viral inactivation, climate implications, and air pollution control methods.

A solution of 5% mass fraction of solute (MFS) NaCl and NaHCO3 with tryptophan was aerosolized using a handheld nebulizer (Mesh Nebulizer Model YM-3R9) into a closed chamber. Chamber conditions were adjusted for relative humidity and CO_2 concentration to determine the effect of these parameters on aerosol pH. A portable CO_2 monitor (SAF Aranet4) recorded temporal changes in CO_2 concentrations and relative humidity in the chamber. WIBS sampled from the chamber at a flow rate of 0.3 liters/minute for 10-20 second intervals at designated points in time over a 90 minute period.

At a higher bulk solution pH, aerosols exhibited a lower fluorescence intensity. Within the chamber, the CO_2 concentration steadily rose over the duration of the experiment. Pairing the temporal evolution of CO_2 concentration in the chamber with the time-resolved fluorescence intensity of aerosols sampled by the WIBS instrument, fluorescence intensity decreased as the CO_2 concentration increased correlating with an increase in aerosol pH.

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2AC.11

Morphological Effects on the Heterogeneous Freezing of Droplets Containing Different Ice Nucleating Particles.
REBECCA CONNER, Natalie Bacallao, Peyton Stiles, Jack Smith, Taylor Peña, Sarah D. Brooks, Ziying Lei, *University of Tennessee*

Atmospheric aerosol particles can act as ice nucleating particles (INPs) and influence cloud formation, precipitation, and radiative forcing. However, ice nucleation remains poorly understood because atmospheric aerosols exhibit complex chemical compositions and morphologies. In particular, how uniformly mixed and phase-separated organic particles influence freezing behavior remains poorly constrained. We investigated immersion freezing in aqueous organic droplets with different morphologies containing various insoluble INPs using a custom-built cooling stage with a high-resolution camera. The chemical composition of the different droplets was characterized by PTIR and Raman spectroscopy. When diethyl sebacate droplets with a core-shell morphology were present, the shell crystallized at warmer temperatures of -8 °C to -13 °C, whereas the core froze at a much lower temperature of -21 °C to -25 °C. Black carbon was placed in different locations within the core-shell diethyl sebacate droplets, and the largest difference between shell crystallization and core freezing temperatures was 13 °C when black carbon was present in both regions. Both K-feldspar and silver iodide promoted warmer freezing temperatures of the core. These results provide new insights into the role of complex organic aerosols in mixed-phase clouds and highlight the need to incorporate particle morphology into the parameters of climate models.

2AC.12

Toward Monitoring the Aging and Mixing of Single Electrodynamically Levitated Aerosol Particles.
ARDEN FLOYD, Cole Sagan, Rachel Mark, Marissa Weichman, *Princeton University*

The treatment of atmospheric aerosols introduces significant uncertainty in climate models. For instance, physical and chemical changes during the aerosols' atmospheric lifetime will impact their direct and indirect climate forcing in ways that are currently difficult to predict. One way to constrain this is via controlled study of the optical properties and hygroscopicity of aerosols undergoing atmospherically relevant aging processes. To this end, we have built a custom single-particle spectrometer for tracking the size and complex refractive index (RI) of single aerosol particles over long timescales in a controlled environment. A charged micron-scale droplet is trapped and levitated in space by a linear quadrupole electrodynamic balance (LQ-EDB) for several hours. The LQ-EDB is housed in a climate-controlled chamber to isolate the impact of humidity and chemical environment. To extract size and complex RI, we collect broadband light generated with a laser-driven light source (LDLS) scattered off the particle at 90 degrees. The scattering spectrum shows characteristic fringe patterns arising from Mie resonances of the particle. Fitting to predictions from Mie theory then allows us to retrieve the size and complex RI from a single spectrum. We have used this framework to fit the size and wavelength dependent RI of sulfuric acid aerosols, which are the main scatterers of the atmosphere. In ongoing work, we are now expanding the capabilities of the platform by implementing incoherent broadband cavity enhanced spectroscopy (IBBCES), which will enable quantification of the extinction signal of a single aerosol. We will use IBBCES to observe the mixing of sulfate aerosols with 4-nitrocatechol (4-NC), a model brown carbon (BrC) that absorbs at UV and near-UV wavelengths. We will track the condensation of 4-NC on the particle over time as a function of vapor concentration and elucidate the magnitude of absorption as well as the core-shell structure of mixed particles.

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2AC.13

Toxicological Impact of Size-Fractionated Incense Smoke on B16 Melanoma Cells Linked to Persistent Free Radicals and Chemical Composition. LI-YING HSIEH, Zhen-Lun Tseng, Wen-Ping Jiang, Chiu-Lan Chen, Ying I. Tsai, *Chia Nan University of Pharmacy and Science, Taiwan*

In Taiwan and Southeast Asia, incense burning remains a significant cultural and religious practice. This study investigates the skin toxicological impact of incense smoke aerosol, specifically exploring interactions among emerging environmentally persistent free radicals (EPFRs), polycyclic aromatic hydrocarbons (PAHs), and water-soluble markers. Incense smoke particles from Taiwanese and Thai varieties were collected using a Micro-Orifice Uniform Deposit Impactor (MOUDI) and segregated into 12 size fractions, ranging from the coarse mode (particle diameter, dp: 2.5–18 μm) to the nuclei mode (dp: 0.005–0.1 μm). Chemical composition, including ionic species and saccharides, was quantified via ion chromatography (IC). At the same time, a suite of 23 PAHs was analyzed using gas chromatography–tandem mass spectrometry (GC-MS/MS) to determine toxic equivalency quantities (TEQ). Electron Spin Resonance (ESR) spectroscopy was utilized to measure non-destructive persistent free radicals (ndPFRs) and water-extracted persistent free radicals (wePFRs). The biological impact was subsequently assessed using B16 melanoma cells as a model system, with cell viability quantified through MTT assays. The results indicate that $PM_{2.5}$ accounted for over 98% of the total mass emitted. Primary indicators, such as potassium, chloride, and levoglucosan, exhibited concentration peaks at 1 μm. Carcinogenic high-molecular-weight PAHs (HMW-PAHs) predominantly adhered to fine particle surfaces, governing the TEQ size distribution. A critical breakthrough revealed a thousand-fold difference in magnitude between ndPFRs (10^{12} spins/g) and wePFRs (10^{15} spins/g), indicating significantly enhanced radical intensity in aqueous states. While ndPFR distribution aligned with PM mass, over 90% of wePFRs were concentrated in the coarse mode (dp > 2.5 μm). Notably, significant cytotoxicity was observed in the nuclei and coarse modes rather than the mass-dominant droplet mode. Thai incense exhibited higher lethality than Taiwanese incense, a result attributed to its elevated total PFR production.

2AC.14

Association Between PM2.5 Exposure and Risk of Pulmonary Function Decline in Asthmatic Children: A Comparative Study of Exposure Assessment Strategies. SUNG CHUL SEO, *SeoKyeong University*

Background Traditional fixed monitoring networks cannot capture individuals' movement patterns and microenvironmental variability, leading to exposure misclassification. This study validated PM2.5 exposure assessment by comparing portable light-scattering sensors (PICO monitors) with two fixed networks: national automatic monitoring (Air Korea, AK) and regional monitoring (KTR) stations. We analyzed correlations between exposure metrics and lung function decline in asthmatic children.

Methods Twenty asthmatic children (mean age 10.7±2.4 years) living in the Seoul metropolitan area were enrolled from December 2019 to February 2020. PM2.5 concentrations were measured using PICO monitors (personal-level), AK (national-scale), and KTR stations (urban-scale). Peak expiratory flow rates (PEFR) were measured twice daily using a digital peak flow meter. Seventy-two-hour cumulative exposure was quantified using five indicators: maximum, mean, median, cumulative exposure, and exceedance frequency. Statistical analyses, including Spearman correlation, restricted cubic spline (RCS) regression, and time-varying Cox proportional hazards regression, were performed.

Results Mean PM2.5 concentrations were 24.4±17.5 μg/m³ (AK), 22.0±18.9 μg/m³ (PICO), and 27.0±23.3 μg/m³ (KTR), all substantially exceeding the WHO guideline of 15 μg/m³. PM2.5-PEFR correlation was strongest with PICO ($r=-0.48$, $p<0.05$) compared to AK and KTR. Multivariate Cox regression analysis showed that each 1 μg/m³ increase in PICO-measured PM2.5 level significantly increased the risk of lung function decline by 7% (HR=1.07, 95% CI 1.04–1.10, $p<0.001$), with superior predictive power (C-index=0.822) compared to AK (0.582) and KTR (0.623). The RCS analysis showed nonlinear dose-response relationships when the PICO-measured PM2.5 levels exceeded 25 μg/m³ (1.67-fold above WHO guideline), indicating threshold effects for acute health impacts.

Conclusions Personal portable monitoring devices (PICO) substantially outperformed two fixed monitoring approaches in capturing exposure variability and predicting risks of lung function decline in asthmatic children. In the future, large-scale long-term prospective studies across different regions, seasons, and populations are needed to establish and validate the exposure-response relationships observed in this study.

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2AC.15

Stability of Environmentally Persistent Free Radicals: Irradiation, Radical Precursors, Autoxidation, and Metal Complex Interactions. B. SAGE LAUPER-COOK, Lena Gerritz, Caitlyn Cruz, Sergey Nizkorodov, Manabu Shiraiwa, *University of California, Irvine*

Environmentally persistent free radicals (EPFRs) are emerging pollutants present in particulate matter (PM) with increased health relevance due to their redox activity forming reactive oxygen species in aqueous extracts. EPFR composition and stability in PM is not well understood. This study aims to identify key drivers of EPFR stability using standard radical precursors, the addition of metal oxides (ZnO and CuO), and real-world sample proxies (indole and naphthalene secondary organic aerosol, plastic burning PM with and without the presence of air). Standard species included various types of quinones, catechols, and a polymer that produce radical species (semiquinone and phenoxy radicals) upon UV irradiation. Electron paramagnetic resonance spectroscopy was used for EPFR detection and decay monitoring. We observed that the EPFR formed from standard radical precursors exhibited three-factor exponential decay, and EPFR generated from secondary organic aerosol and PM exhibited longer lifetimes than the standards. Plastic-burning PM flamed in air demonstrated the longest lifetime, highlighting the implications for long-range transport of burn materials. We found that while CuO provided stabilization for standard EPFRs, ZnO promoted EPFR growth over the decay period. We also observed that under nitrogen, EPFR did not show the same growth demonstrated in oxygenated conditions, illustrating the critical role of oxygen in EPFR formation. Finally, we observed that the EPFR linewidth decreased with decay across most samples, exhibiting a narrowing of radical diversity with time. We suggest that autoxidation and metal oxide identity are the primary drivers of EPFR lifetime in PM, and g-factor and linewidth changes provide qualitative insight into compositional changes of radical populations over time.

2AC.16

Heterogeneous Uptake of O3, HCl, and N2O5 on Al2O3 at Low Temperature: Implications for Stratospheric Aerosol Injection and Rocket Emissions. YUAN LIU, Shu-Wen You, Uma Puttu, Rajan K. Chakrabarty, Lu Xu, *Washington University in St. Louis*

Stratospheric aerosol injection (SAI) has been proposed as a geoengineering strategy to mitigate global warming by increasing planetary albedo. Implementation of SAI would increase stratospheric aerosol surface area, potentially enhancing heterogeneous chemistry and ozone loss. However, these impacts remain poorly constrained due to limited kinetic data under stratospheric conditions. Al_2O_3 is a promising SAI candidate and can also be released into stratosphere via rocket emissions, making it a representative surface to study. Here, we investigate the heterogeneous uptake of O_3, HCl, and N_2O_5 on Al_2O_3 at stratospherically relevant temperatures with an aerosol flow tube. The measured uptake coefficients indicate efficient uptake of key chlorine reservoir species and reactive nitrogen oxides, along with measurable direct ozone loss. Our results provide critical kinetic constraints for comprehensively evaluating the ozone impacts of future SAI deployment and rocket emissions in atmospheric models.

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2AC.17

In Situ Surface Tension Measurement of Deliquesced Aerosol Particles. MASAO GEN, Masayoshi Nakamura, *Chuo University*

The surface tension of aerosol particles can potentially affect cloud droplet activation. Hence, direct measurement of the surface tensions of deliquesced aerosol particles is essential but is challenging. Here, we report in situ surface tension measurements based on a novel method that couples a linear quadrupole electrodynamic balance (EDB) with quasi-elastic light scattering (QELS). The EDB-QELS is validated using surface tension measurements of atmospherically relevant inorganic and organic droplets. The surface tension results reasonably agree with the reference values in the range of ∼50–90 mN m–1. We find a significant size dependence for sodium chloride droplets containing surface-active species (sodium dodecyl sulfate) in the size range of ∼5–18 μm. The surface tension increases from ∼55 to 80 mN m–1 with decreased size. Relative humidity (RH)-dependent surface tensions of mixed ammonium sulfate (AS) and polyethylene glycol droplets reveal the onset of liquid–liquid phase separation. Droplets containing water-soluble matter extracted from ambient aerosol samples and 2.3–2.9 M AS exhibit a ∼30% reduction in surface tension in the presence of ∼50 mmol-C L–1 water-soluble organic carbon, compared to pure water (∼72 mN m–1). The approach can offer size-resolved and RH-dependent surface tension measurements of deliquesced aerosol particles.

2AC.18

A Trial Methodology Towards Airborne Nanoparticle Analysis Using Single-Particle Inductively Coupled Plasma Mass Spectrometry. FATIMA AHMAD, Taryn Waddey, Patrick Chepaitis, *UL Research Institutes*

Environmental particulates pose a threat to air quality and human health. Established analytical and inorganic methods can provide general information about contaminant concentrations but they fail to offer detailed insights into the characteristics of individual particles, such as their size and elemental composition. It's crucial to characterize the elemental composition of these particles to research the impact of inhaling nanoparticles. This characterization can enhance the study of potential particle deposition locations in the human body and the associated mechanisms of chemically mediated toxicity. Single Particle Inductively Coupled Plasma Mass Spectrometry (SP-ICP-MS) collects recorded pulses, which each represent a single nanoparticle (NP). The frequency of the pulses is directly related to the number concentration of NPs, and the intensity of each pulse is proportional to the diameter of each elemental NP. This ability allows SP-ICP-MS to provide information on the size distribution of nanoparticles, as well as the dissolved concentration of the analyte. This study aims to establish a sampling technique that mimics the inhalation of nanoparticles to determine the individual elemental characterization of airborne environmental particulates. A validated SP-ICP-MS method using dissolved gold (Au) and gold nanoparticle standards with established concentrations and sizes constituted the groundwork for an air sampling technique. Preliminary data has shown that a 30 nm Au NP standard recovered at 34% from a trial air methodology, which is greater than previous works have shown. Heavy metals found in environmental particulates such as lead, arsenic, and vanadium can be detected with this method catered to nanoparticles.

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2AC.19

Drying of Aqueous Aerosol Mimic Solutions. THOMAS MESZAROS, Melissa Galloway, *Lafayette College*

Evaporation is an important part of cloud processing where carbonyl-containing aerosols react with ammonium salts in the aqueous phase before going through a number of dissolution/evaporation cycles. It has been shown that evaporation can influence the reactions that happen in these aerosols and can form light-absorbing species called brown carbon, which can lead to positive radiative forcing and has negative impacts on climate. The process of evaporation in aerosol particles is typically overlooked in many atmospheric studies even though it is a significant part of cloud processing. Structural and light-absorption properties of dried and aqueous carbonyl containing aerosol mimics were characterized using UV-visible spectroscopy and supercritical fluid chromatography–mass spectrometry (SFC-MS). By using these results to determine differences in the reaction pathways occurring in these carbonyl systems as water is removed from them, the significance of evaporation on aerosol chemical composition and physical properties can be better understood.

2AC.20

Carbonyl and Ammonium Sulfate Product Identification in Aqueous Aerosol Mimics. JUNE MORISHIGE, Emily Bilko, Thomas Meszaros, Nolan Sirgany, Brian Henesey, Daniel Griffith, Melissa Galloway, *Lafayette College*

Secondary organic aerosol (SOA) make up a significant portion of atmospheric particulate matter and contain organic compounds that can react to form brown carbon chromophores. Due to their ability to absorb UV and short wavelength visible light, these compounds are implicated in positive radiative forcing and are thought to contribute to global warming. Carbonyls such as methylglyoxal and glycolaldehyde are found in SOA and are known to react with ammonium sulfate found within aerosol, however the products of their cross reactions have not yet been explored. Using varying ratios of carbonyls in ammonium sulfate solution, we mimic the bulk phase of aqueous SOA and analyze the resulting products via supercritical fluid chromatography-mass spectrometry. UV-vis spectroscopy will also be used to visualize the shifts in light absorption due to the presence of brown carbon, leading to a deeper understanding of how these products from carbonyl mixtures impact radiative forcing.

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2AC.21

Physical Properties of Aged Carbonyl and Ammonium Sulfate Aerosol Mimics. NOLAN SIRGANY, Tsering Youdon, Joseph Woo, Melissa Galloway, *Lafayette College*

Multifunctional carbonyls such as methylglyoxal, glycolaldehyde, and glyoxal, along with ammonium sulfate (AS) are all prevalent within atmospheric aerosols. Aqueous reactions of the carbonyls and AS result in formation of atmospheric brown carbon, which are known to contribute to global warming due to their positive radiative forcing. As the system reacts and the brown carbon compounds form, changes in physical properties, such as surface tension, light absorbance, and fluorescence are observed. Within the reacting system, numerous products form simultaneously and each can individually impact the physical properties of the aerosol droplet. Therefore, it is not only important to understand the overall physical effect that interactions of carbonyls and AS have on a droplet, but also what specific products are driving this observed change. Aqueous aerosol mimics containing different mixtures and molar ratios of carbonyls and ammonium sulfate were aged. The resulting physical changes were analyzed with uv-vis spectroscopy, tensiometry, and fluorescence spectroscopy. It is necessary to better understand the physical implications that these interactions have on atmospheric aerosols in order to accurately model the impact of carbonyl/AS reactions on the environment.

2AC.22

Mechanistic Insights Into the Acid-Catalyzed Transformation of Lignin-Derived Coniferaldehyde. ERIK JACKSON, Sergey Nizkorodov, Yuge Chun, Wendy Tran, *University of California, Irvine*

Biomass burning emits large quantities of organic aerosols containing light-absorbing brown carbon (BrC), a major contributor to atmospheric warming. While primary BrC emissions are well documented, secondary BrC remains poorly understood and forms through complex aging processes driven by photo-oxidation, solar radiation, and acid catalysis. In regions of the troposphere enriched with acidic aerosol liquid, atmospheric sulfuric acid (H_2SO_4), derived from oxidized sulfur dioxide (SO_2), promotes oligomerization and condensation of lignin-derived monomers into potent light-absorbing chromophores. Herein, we investigate the structural transformations and mechanistic pathways of coniferaldehyde, a primary lignin-derived monomer, under atmospherically relevant acidities. Using spectroscopic and spectrometric analyses, we reveal the molecular changes that govern its optical properties and identify key reaction intermediates and oligomeric products formed during acid-catalyzed aging. These findings elucidate the chemical changes in lignin-derived secondary BrC, providing critical structural insights for evaluating the radiative impacts of aged biomass-burning plumes.

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2AC.23

Experimental Determination of Air–Water Partition Coefficients for PFAS and Comparison with Thermodynamic Models. AMIR BABAEI-GHAREHBAGH, Joowon Kim, Ke He, Lee Blaney, Christopher Hennigan, *University of Maryland, Baltimore County*

Per- and polyfluoroalkyl substances (PFAS) are persistent environmental contaminants whose atmospheric fate and transport strongly depend on partitioning between air and water. Air–water partition coefficients (K_{aw}) are therefore important parameters for predicting PFAS transport, wet and dry deposition, and exchange between the atmosphere and aqueous environments. However, experimentally measured K_{aw} values are available for few PFAS, and estimates from prediction models are substantially different. This study aimed to experimentally determine air–water partitioning for PFAS with a range of structures and to evaluate the performance of existing thermodynamic and physicochemical property models. Initial measurements focused on a homologous series of perfluoroalkyl carboxylic acids (PFCAs). Partitioning was measured using a variable-phase-ratio headspace approach coupled to PFCA analysis by liquid chromatography with tandem mass spectrometry. Measurements at multiple temperatures and pH conditions were used to examine the effects of molecular structure, temperature, and ionization on observed partitioning behavior. Experimental results were compared with predictions from EPI Suite, SPARC, COSMOtherm, and ABSOLV. Preliminary measurements demonstrated temperature-dependent air–water partitioning across the PFCA series and highlighted the importance of measuring the apparent partitioning of PFAS that are mostly present as anions in solution. Comparisons with model predictions revealed substantial differences among estimation approaches and emphasized the need for additional experimental constraints. Ultimately, this work expands the limited PFAS partitioning database and supports improved assessment of PFAS atmospheric transport and environmental fate.

2AC.24

Modulation of Fenton-like Processes and Hydroxyl Radical Generation by Organic Complexation in the Aqueous Phase. YOUSSEF HARB, Pascale Lakey, Lena Gerritz, Sergey Nizkorodov, Manabu Shiraiwa, *University of California, Irvine*

Short-chain dicarboxylic acids and catechol have been detected in biomass burning aerosols. These aerosols are frequently mixed with mineral dust, which constitutes a major source of atmospheric iron. Previous studies have shown that complexation of Iron with organic ligands could affect the kinetics of dark Fenton processes; however, the effects of complexation on OH formation remain poorly quantified. We employ electron paramagnetic resonance spectroscopy combined with a spin-trapping technique to quantify OH radicals in mixtures of Fe ions and various ligands including catechol, oxalic acid, succinic acid, and malonic acid. We reveal that OH radical concentrations initially rise as the concentration of oxalate increases but subsequently decline at higher concentrations due to the scavenging by oxalate itself. Additionally, as simulated in our kinetic model, the generation of OH radicals depends on the speciation of Fe(II)-oxalate complexation. The presence of succinic acid slightly decreases the trapped OH signal but reveals no clear dependence within the examined concentration range. Conversely, malonic acid, at the higher concentration ratios, stabilizes the levels of trapped OH radicals. The mixture of Iron(II) and catechol exhibits a much rapid decline in adduct signal with time as compared to Iron(II) alone. By utilizing an oxidation-reduction potential probe, we found that the presence of organic ligands could affect the redox environment of Fenton systems by lowering the overall pE of the system. These findings could enhance our understanding of the role of metal-organic complexation on aqueous-phase oxidizing capacity.

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2AC.25

Interfacial Tension of Organic and Aqueous Ammonium Sulfate Phases. KC WAHL, Alison Bain, *Oregon State University*

Atmospheric aerosol properties strongly influence cloud formation, climate, and air quality. Aerosols can have highly complex compositions that include aqueous, organic, and inorganic compounds. Commonly, under suitable relative humidity, aerosols can experience liquid-liquid phase separation (LLPS) in which the organic and aqueous phases can become distinct phase separated regions in a single particle. The interface between the two phases has been proposed as a key property necessary to predict the relative humidity at which LLPS may occur due to its impact on the total energy of the particle. Specifically, the energetic barrier existing at the boundary between them is called interfacial tension. This tension, along with other thermodynamic factors, are influential in determining whether aerosols will become phase separated or not, therefore altering their optical and chemical properties.

Here, we show measurements of interfacial tension between aqueous salt and organic phases of macroscopic phase separated systems. We investigate atmospherically relevant water soluble carboxylic acids and ammonium sulfate in the aqueous phase and insoluble organics n-hexadecane and squalene in the organic phase. First, the surface tension of each pure component and interfacial tension of each system was measured using the du Noüy ring method with a force tensiometer. Next, experimental surface tension data was used to predict interfacial tension using the two prevalent approximate interfacial tension models: the Girifalco–Good equation and Antonov's rule. The models were found to be inaccurate with systems of increasing complexity. These measurements provide the necessary data to improve model predictions of interfacial tension and can be used to predict phase separation in atmospheric aerosol.

2AP.1

Experimental Investigation of Coagulation of Neutral-Charge Particle Pairs with Unequal Sizes. BRANDON BOREN, Masa Kasem, Hui Ouyang, *The University of Texas at Dallas*

Brownian coagulation of ultrafine particles (nm) is a fundamental process governing particle growth and evolution in atmospheric aerosol systems and nanoparticle synthesis, where colliding particles adhere to form larger particles. In the atmosphere, neutral and charged aerosols coexist, and coagulation between those particles is unavoidable. To better predict aerosol size distributions and particle concentrations, there is a need to incorporate neutral-charge interaction into current coagulation models, yet, experimental work investigating neutral-charged coagulation remains limited. In this study, we experimentally measured neutral-charged coagulation rates for unequal particle-size pairs under two charge configurations: Case (1) charged small particles colliding with neutral larger particles, and Case (2) neutral small particles colliding with charged larger particles with varied charge fractions. Using a tandem-DMA setup, size-selected monodisperse sodium chloride (NaCl) aerosols were introduced into a 0.5 stainless-steel chamber under controlled conditions. Coagulation rates were measured for a variation of particle-size pairs consisting of small particle diameters between 15-50 nm and large particle diameters between 40-140 nm. Our measurements show that, in Case (1), coagulation rates are enhanced in neutral-charge pairs compared to the neutral-neutral particle pair when the charged particles are much larger than its colliding partner. While in Case (2), all coagulation rates are enhanced for the neutral-charge pairs compared to the neutral-neutral pairs, where the enhancement depends on charge fractions, and that with a higher fraction shows a stronger enhancement. These findings suggest that neutral-charged interactions can enhance coagulation beyond neutral-neutral aerosol interactions. This might improve models for predicting atmospheric particle survival and cloud condensation nuclei (CCN) formation rates in atmospheric aerosol evolution.

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2AP.3

Characterizing the Continuum Between Bipolar and Unipolar Charging. TYLER J. JOHNSON, Gregory Smallwood, Conor Ruzycki, Jason S. Olfert, Robert T. Nishida, *Atmose Ltd.*

Bipolar charging introduces ions of both polarities into an aerosol stream, which charge the particles through a combination of electrostatic and diffusive forces. When ion concentrations are sufficiently high and their interaction times with particles are sufficiently long, charging rates reach a steady state due to the balanced interactions of positive and negative ions with the particles. However, asymmetries in ion mobilities and concentrations between positive and negative ions, quantified by the ion conductivity ratio (γ), shift the charge distribution away from steady state due to preferential diffusion losses of one ion polarity downstream of the charging region [1]. This deviation, as well as additional deviations introduced by the temporal response of the charger [2], are not considered in conventional bipolar charging models and measurements.

This work takes aerosol charging one step further by controlling the ion conductivity ratio (γ) to control particle charge, spanning from unipolar negative to bipolar to unipolar positive charging, using a low-activity source that generates bipolar ions. This approach demonstrates the continuum between bipolar and unipolar charging, allowing an almost infinitely adjustable particle charge between these limits. This is demonstrated by the average charge per particle measured across this continuum, and by comparisons with numerical modelling for further insights. This method enables precise and stable control of particle charging and can be applied to both existing and emerging aerosol measurement techniques.

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2AP.4

Turbulence, Surface Complexity, and Morphology Controls on Submicron Particle Dry Deposition: Insights from a Controlled Chamber Study. JONAH HAZELWOOD, Markus Petters, Nicholas Meskhidze, *North Carolina State University*

Size-resolved particle dry deposition velocities (v_d) for submicron particles remain among the largest sources of uncertainty in regional and global aerosol models, yet controlled laboratory constraints on the governing mechanisms are scarce. We conducted experiments in a spherical aluminum chamber (diameter 91.4 cm, volume ~0.4 m^3) to systematically investigate how turbulence intensity, surface type and complexity, and particle morphology govern v_d across the 15–300 nm mobility diameter range.

Deposition velocities were determined using two independent methods: a chamber concentration decay approach and a direct filter collection and re-atomization technique. Three aerosol types with distinct morphological and compositional properties were examined: sodium chloride (NaCl), polystyrene latex (PSL) spheres, and black carbon (BC) aggregates generated by ethylene combustion.

Key findings are threefold. First, turbulence exerts strongly size-dependent control on v_d: viscous sublayer suppression produces a local minimum near 70–150 nm under intermediate turbulence regimes, an effect that diminishes at higher turbulence intensities. Second, flow-permeable, vegetation-like surfaces enhance normalized v_d by factors of 2–3 for particles smaller than 50 nm, substantially exceeding predictions based on surface area alone and highlighting the importance of surface morphological complexity in deposition parameterizations. Third, particle morphology introduces up to an order-of-magnitude spread in v_d at a given mobility diameter: BC fractal aggregates exhibit a characteristically flat v_d-size relationship inconsistent with spherical-particle parameterizations currently used in models. Filter-derived v_d values for PSL particles (170, 195, and 308 nm) agree with decay-method results to within a factor of 2, validating filter collection as an independent and quantitatively reliable measurement approach. Given BC's chemical inertness and recoverability from filter surfaces, these results motivate deployment of analogous filter-based methods for direct, size-resolved v_d measurements under ambient atmospheric conditions.

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2AP.5

Reduced-Order Modeling Based on All-Atoms Molecular Dynamics Simulations of Titania Nanoparticle Sintering.

JAVIER GALLARDO, José Morán, Jerome Yon, *Normandie Université, INSA Rouen, CORIA, Rouen, France*

The sintering of aerosol nanoparticles is ubiquitous in particle synthesis processes, including flame- and plasma-based methods. In these environments, sintering competes with other particle growth mechanisms, such as coagulation, and strongly affects particle morphology and, consequently, their physicochemical and optical properties. Classical sintering models, such as the formulation introduced by Koch and Friedlander (1990), often rely on a single dominant transport mechanism, including grain boundary, lattice, or surface diffusion. As a result, they may have difficulties describing the multi-stage nature of nanoparticle sintering, especially over temperature ranges where the particle morphology evolves from solid-like to highly mobile or partially liquid-like regimes. To address these limitations, this work explores a reduced-order description of titania nanoparticle sintering based on morphology descriptors and atomistically resolved diffusion information obtained from molecular dynamics simulations.

We simulate the neck formation and shape evolution of sintering nanoparticle dimers using all-atom molecular dynamics simulations in LAMMPS. The system consists of two crystalline, monodisperse anatase TiO2 nanoparticles with a diameter of 5nm. Simulations are conducted at different initial temperatures, allowing the effect of temperature on neck growth and atomic mobility to be analyzed. After thermal equilibration at the target temperature, the dimers are evolved in time under a microcanonical ensemble. Interatomic non-bonded interactions are described using the Matsui-Akaogi force field, which provides a computationally tractable representation of TiO2. Sintering morphology is reconstructed using a level-set-based geometrical description adapted from Yon et al. (2016), allowing the evolution of the particle diameter, neck radius, center-to-center distance, and smoothness parameter to be tracked.

The level-set reconstruction captures the evolution of the morphological descriptors throughout the simulated time for 5nm TiO2 dimers at different temperatures. Resulting trends suggest that neck growth does not follow a single pathway. At higher temperatures, the neck growth is accompanied by a relatively constant effective particle diameter and a progressive decrease in the center-to-center distance, which is consistent with densifying neck-growth mechanisms. In contrast, at lower temperatures, this densifying stage appears shorter and less effective. After initial contact, the neck can continue to grow while the center-to-center distance remains nearly unchanged, suggesting a stronger contribution of non-densifying, surface-diffusion-like mechanisms. Radially resolved self-diffusion coefficients further show enhanced atomic mobility near the nanoparticle surface compared with the core, supporting the use of spatially dependent diffusivity descriptors in reduced-order sintering models which is an ongoing theoretical effort.

2AP.6

Spectrographic Methods for Uncovering Optical Properties of Mineral Dust Aerosols.

KURT EHLERS, Keira Gilmore, Talia Wachsman, Reid Davis, Prakash Gautam, Christopher M. Sorensen, Hans Moosmüller, *Truckee Meadows Community College*

Mineral dust aerosols are small dust particles commonly suspended in earth's atmosphere with important implications for climate change, ecosystems, human health, and visibility, and optical communication and remote sensing systems. Unfortunately, very little is known about mineral dust optical properties and their impacts impacts on human and natural systems. We present our progress on using spectrographic measurements to uncover optical properties of common atmospheric mineral dust aerosols. The experimental foundation of our method is to suspend the particles in non-absorbing media of a variety of refractive indices and measure the spectral light scattering from and extinction through the suspension. Our undergraduate interns (KG, TW, and RD) are carrying out experiments at the Desert Research Institute, Reno, NV on particles such as gold nanoparticles and Polystyrene Latex (PSL) spheres, whose optical properties are well documented, to test various analytical methods based on Rayleigh and Mie theories.

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2AP.7

Experimental Development of Integrated Ensemble and Single-Particle Aerosol Optical Measurements Across near Full Angular Range. PRAKASH GAUTAM, *Desert Research Institute*

Atmospheric aerosol particles exhibit highly variable optical behavior due to differences in particle size, morphology, composition, and mixing state. Ensemble optical measurements provide important information on bulk aerosol scattering properties; however, they inherently average over particle populations and therefore obscure particle-to-particle variability in optical behavior. In this work, we demonstrate experimental capability for near full-angular (0.32°–178.6°) optical characterization of aerosol particles using a wide-angle ensemble scattering system together with the development of a complementary single-particle optical trapping framework. Scattering intensity measurements are analyzed in both θ-space and Q-space (intensity vs. scattering wave vector magnitude, q) representations, providing complementary sensitivity to particle size distributions and structural scattering behavior across forward-, side-, and large-angle scattering regimes. This work represents an important step toward integrating ensemble and single-particle optical characterization within a unified experimental platform to better understand relationships between particle-scale variability and ensemble optical observables relevant to atmospheric and remote sensing applications.

2AP.8

Using Fluorescent Surfactants to Probe Interfacial Transport in Levitated Viscous Microdroplets. DERRECK HARRIS, Michael Jacobs, *Texas State University*

The air–water interface of viscous, glass-like microdroplets plays a critical role in transport, reactivity, and nonequilibrium behavior. Owing to their high surface-area-to-volume ratios, interfacial processes often dominate microdroplet physical and chemical behavior. In these systems, bulk transport is limited by slow diffusion within the viscous interior, whereas surface transport is typically faster and can govern molecular redistribution and reaction pathways. Surface tension gradients may also generate Marangoni flow, influencing interfacial transport and molecular organization through coupled flow, diffusion and interfacial effects that remain poorly understood in highly viscous environments, where increased viscous drag can strongly alter flow behavior. Despite growing interest in microdroplet chemistry, the kinetics and surface behavior underlying these processes are still unclear, particularly in levitated viscous droplets where the absence of a substrate enhances surface effects.

Here, fluorescent surfactants, specifically alkyl esters of Rhodamine B, are used as probes to investigate interfacial transport in levitated viscous microdroplets with controlled compositions. Trapped fluorescent-surfactant-laden microdroplets are probed using our recently developed quadrupole electrodynamic trap confocal microscopy (QET-CM) technique, which enables spatial mapping of fluorescent molecules within levitated droplets over time. By coalescing two droplets within the trap (e.g., a surfactant-laden droplet and a surfactant-free droplet) and monitoring the evolution of fluorescent probe distributions, we directly measure transport processes in microdroplets. Comparisons between surface-active and surface-inactive fluorescent probes allow surface and bulk transport rates to be distinguished in highly viscous environments. Preliminary results indicate that transport and flow behavior depend strongly on surfactant structure and droplet environment, with distinct redistribution timescales and flow patterns observed under different conditions. These findings demonstrate that fluorescent surfactants are effective probes of interfacial transport and provide insight into mechanisms governing Marangoni flow and related surface-driven processes in viscous microdroplets.

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2AP.9

Characterizing Contributions to Cloud Condensation Nuclei and Cloud Droplet Number Concentrations from New Particle Formation in a Subtropical Forested Environment. AJITH THENOOR CHANDRAN, Xiangxinyue Meng, Kyle P. McCary, Alan R. Gonzalez, Heewon Yim, Yuzhou Wang, Qi Ying, Maria A. Zawadowicz, Yue Zhang, *Texas A&M University*

New Particle Formation (NPF) is a major source of aerosols and cloud condensation nuclei (CCN); however, its overall impact remains uncertain due to variability in atmospheric conditions and chemical species involved. There is limited information on how NPF contributes to CCN in the Southeastern U.S., where strong interactions of biogenic and anthropogenic emissions exist. To bridge this knowledge gap, we investigate NPF over a subtropical forested site at the Bankhead National Forest (BNF), southeastern United States, and quantify its contribution to CCN and cloud droplet number concentrations (CDNC) from Nov 2024 to Oct 2025. The data from a suite of instruments, including a scanning mobility particle sizer, a time-of-flight aerosol chemical speciation monitor (ToF-ACSM), and a CCN counter, were combined with an adiabatic cloud parcel model. Results show that Type I (characterized by well-defined particle growth) NPF events accounted for ~18% of occurrences over the year and were the least frequent in summer (~4%). These events predominantly occurred under clear-sky conditions and low relative humidity, while condensation sink and wind speed played a secondary role. Results from the hybrid positive matrix factorization (PMF) analysis imply that the nucleation mode is primarily associated with sulfate, ammonium, and highly oxidized organics, whereas the particle growth is dominated by organics. Enhancements in CCN and CDNC due to NPF were quantified by comparing pre-event and event conditions. A parameterization based on pre-event particle number concentration and organic mass established relatively accurate predictions of CCN enhancement, while further including size-resolved organic factors from hybrid PMF showed even more dramatic improvement in predicting the enhancement of CCN. These findings provide a quantitative and parameterized framework connecting NPF, growth, and its contribution to CCN and CDNC, offering improved constraints for representing aerosol-cloud interactions in subtropic forested environments.

2AP.10

New Particle Formation in an Arid Environment: Role of Multiple Atmospheric Processes. ANUJ SHRIVASTAVA, Deepika Bhattu, *Indian Institute of Technology, Jodhpur*

New Particle Formation (NPF) is an important atmospheric process that influences aerosol number concentrations, cloud condensation nuclei (CCN), human health, and climate, yet it remains poorly understood in arid environments. In this study, NPF was investigated over Jodhpur, an arid region in western India, during October-November 2025. To understand the governing mechanism, a multi-dataset approach was adopted. Particle number size distributions were measured by using Scanning Mobility Particle Sizer, supported by in-situ observations (gas analyser and automatic weather station), satellite products (TROPMI), reanalysis data (ERA5), and back-trajectory analysis.

During the study period, around 16% (8 out of 50) of the days showed clear NPF events, and most of the events initiated in late afternoon and persisted overnight, suggesting a coupling between daytime photochemical production of precursor vapours and nighttime conditions favourable for particle growth and survival. The average growth rate, particle formation rate, and condensation sink were 6.65 nmh-1, 4.33 cm-3s-1, and 26.75×10-3 s-1, respectively, indicating moderate particle formation under pre-existing aerosol loading. Back-trajectory analysis indicates that most of the events were regional transported and associated with air masses arriving from northern regions.

Most NPF events occurred under elevated Ozone, with low relative humidity, clear sky, low-to-moderate wind, and weak vertical motion. Additionally, the majority of events occurred under a nitrogen oxides (NOx)-limited regime, with low nitric oxide-to-nitrogen oxide ratios, consistent with photochemically aged air masses. NPF events were also associated with a significant increase in accumulation-mode particles (diameter >100 nm), indicating growth to CCN-relevant sizes, with a strong negative correlation with wind speed, suggesting accumulation under low wind conditions. Overall, this study explores how different types of NPF events are affected by specific phenomenon/process or by mixed processes. The variability across events suggests that there is no single dominant mechanism, but rather multiple processes control formation and growth.

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2AP.11

Characterizing Horizontal Gradients of Aerosol Pollution and Chemical Speciation Across Oklahoma. SANDRA MARCELA LORIA SALAZAR, Emily West, Connor Flynn, Jens Redemann, *University of Oklahoma, School of Meteorology*

Ambient particulate matter (PM) pollution remains a critical public health concern across the United States, with disproportionate impacts in certain regions. This study investigates the spatial distribution and chemical speciation of aerosol pollutants across Oklahoma, with a particular focus on horizontal gradients and their implications for environmental health. According to Disability-Adjusted Life Years (DALYs) data, Oklahoma exhibits a modest but statistically significant increase in the proportion of total deaths attributable to ambient PM pollution compared to the national average. This elevated burden underscores the need for region-specific air quality assessments and targeted mitigation strategies.

To address this, we leverage data from the U.S. Environmental Protection Agency's Interagency Monitoring of Protected Visual Environments (IMPROVE) and Chemical Speciation Network (CSN) monitoring stations. Additionally, we incorporate data from the SPARTAN IMPROVE Comparison Experiment (SPICE); a field campaign at the Department of Energy's Atmospheric Radiation Measurement (ARM) Southern Great Plains site. SPICE serves as a proof-of-concept for deploying "aerosol pods," small, free-standing instrument platforms designed to augment existing infrastructure and fill critical measurement gaps. By integrating these diverse datasets with detailed chemical analysis, our research seeks to identify dominant aerosol sources, assess spatial variability, and evaluate pollutant transport mechanisms across the Southern Great Plains. The findings will inform science-based policy interventions and support efforts to reduce health disparities linked to air pollution exposure in Oklahoma and similar regions.

2AP.12

When "Cooling" Aerosols Cause Warming. LONGRUI ZHANG, Rajan K. Chakrabarty, Taveen S. Kapoor, Prabhav Upadhyay, *Washington University in St. Louis*

Stratospheric aerosol injection (SAI) using sub-micrometer alumina particles is proposed to cool the climate by raising planetary albedo, but its global radiative efficacy is poorly understood. We perform offline radiative transfer simulations for a purely scattering alumina layer in the stratosphere (18–23 km) and find a counter-intuitive result: at low solar zenith angles (SZA) above bright surfaces — snow, low-latitude deserts — the aerosol produces positive top-of-atmosphere radiative forcing despite zero particle absorption (k = 0). The 16-stream DISORT solver yields up to ~+2 W m^{-2} at SZA = 5° and surface albedo 0.6; the two-stream RODENTS approximation systematically underestimates this signal, and conventional daily-averaged metrics mask the diurnal warming peaks most relevant to snowmelt.

To explain this phenomenon, we propose a "ping-pong" single-layer adding model that resolves the mechanism analytically. The aerosol slab presents two distinct effective reflectances: R↓ for the reflected fraction of collimated downwelling beam (short, near-vertical path) and R↑ for the reflected fraction of diffuse upwelling beam reflected by the Lambertian surface (broad angular distribution, longer mean path). With Φ = R↑/R↓ exceeding unity at low SZA, photons are trapped in successive bounces between layer and surface — the "ping-pong" that quantitatively reproduces the simulated forcing. This mechanism is validated numerically by showing: Φ depends only on the layer's intrinsic angular scattering properties, not on the underlying albedo. Meanwhile, experimental validation of the mechanism is ongoing via lab-scale study of alumina deposition on snow surfaces.

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2AP.13

Co-Injection of Alkene and Sulfur Vapor Precursors as a Practical, Lower-Sulfur Alternative for Stratospheric Aerosol Injection. DUZITIAN LI, Mingyi Wang, Hongwei Sun, David Keith, *The University of Chicago*

Stratospheric aerosol injection (SAI) is a proposed geoengineering strategy by introducing reflective aerosol particles or their precursors into the stratosphere to reducing incoming solar radiation. The efficacy of SAI particles strongly depends on their sizes, yet conventional sulfur dioxide (SO_2) injection is limited by slow in-situ oxidation and poor control over particle size, while direct accumulation mode sulfuric acid (AM-H_2SO_4) injection may face applicable challenges. Here we examine an alternative sulfur-based injection in which a small amount of alkene, tetramethylethylene (TME), is co-injected with SO_2 to enhance in-plume oxidation and accelerate H_2SO_4 formation. TME ozonolysis rapidly generates hydroxyl radicals (OH), increasing early H_2SO_4 vapor concentration by up to two orders of magnitude relative to SO_2-only injection, and the enhancement sustained over the photochemical time window. Coupled microphysical simulations indicate that this accelerated oxidation can promote the formation and growth of accumulation-mode particles, with number concentration enhanced by a factor of 100–1000. These results suggest that by improving sulfur-use efficiency while preserving a sulfate-based aerosol composition, alkene-SO_2 co-injection may offer a practical, lower-sulfur pathway for SAI.

2AP.14

Experimental Simulation of Cloud Formation and Aerosol Evolution in Planetary Atmospheres. MICHAEL PAUKEN, Luca Valdarno, Marcel Veismann, Dejian Fu, Rahul Kushwaha, Joseph Salazar, Richard Flagan, Will Cantrell, Adrian Castro, *Jet Propulsion Laboratory, Caltech*

Clouds and aerosols shape the thermodynamic, radiative, and chemical behavior of planetary atmospheres, yet their formation pathways and environmental impacts remain poorly constrained due to sparse in situ measurements and the difficulty of reproducing extreme extraterrestrial conditions. To address these gaps, we present two complementary experimental platforms—the Venus Cloud Chamber (VCC) and the Planetary Cloud Aerosols Research Facility (PCARF)—that provide a unified, physics-based framework for advancing planetary climate science and mission readiness.

The VCC recreates the corrosive, sulfuric-acid cloud environment of Venus to evaluate the durability of materials, instruments, and components for future balloon and aerobot missions. By generating Venus-relevant aerosol populations and reproducing cloud-layer temperatures and chemical compositions, the facility enables systematic corrosion testing and calibration of aerosol mass spectrometry techniques. Key capabilities include an aerosol generator tuned to Venus droplet sizes, soft X-ray charge neutralization, and precise thermal control near ~60°C. These features allow realistic assessment of degradation pathways and support development of long-lived instruments for the Venus atmosphere.

PCARF complements this work with a microphysics-driven approach to cloud and aerosol formation across diverse planetary environments. Equipped with a chemical feed system, a vacuum chamber spanning terrestrial to rarefied pressures, and a temperature-controlled shroud capable of establishing Rayleigh–Bénard convection, PCARF supports controlled studies of nucleation, condensation, coagulation, and particle growth. Diagnostics including mass spectrometry, mobility sizing, optical scattering, and particle image velocimetry enable detailed characterization of particle composition, size, and transport.

Together, the VCC and PCARF establish an integrated experimental infrastructure that strengthens interpretation of observations, informs mission design, reduces environmental risk, and improves predictive understanding of cloud-driven processes across planetary climates.

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2AP.15

Determining the Optical Properties of Single Aqueous Carbonate-Containing Aerosol Droplets. KELSI RAMOS, Emily Werner, Alison Bain, *Oregon State University*

Stratospheric aerosol injection (SAI) has been proposed as a short-term method for mitigating climate change. To be effective, the injected aerosol must scatter solar radiation back out of the atmosphere. The scattering properties of aerosol particles are described by their size, geometry, and refractive index. Aerosols with a large real part of the refractive index (RI) are more efficient at scattering light and thus are being considered for use in SAI. Solid carbonate salts have specifically been identified as an aerosol of interest for SAI due to their large RI, low cost, and high natural abundance. Carbonate salts injected into the stratosphere will mix with existing liquid-phase sulfate aerosol and form aqueous carbonate- and bicarbonate-containing aerosol. The optical properties of this aerosol are poorly understood.

Here we have determined the wavelength-, relative humidity (RH)-, and pH-dependent refractive index of aqueous carbonate-containing aerosol droplets using optical trapping and cavity-enhanced Raman spectroscopy. This data was fit with the effective oscillator model to determine oscillator parameters for carbonate salts, as well as for carbonate and bicarbonate ions. These parameters can be used to predict the refractive index of aqueous aerosol droplets containing one or more solutes. These predictions can provide insight into the optical properties of aqueous carbonate systems, including aerosol resulting from SAI and mineral dust.

2AP.16

Controlling Asperity Width for Aerosol-Surface Contact and Its Effect on Particle-Surface Adhesive Forces. HENRY MACPHERSON, Matthew Jones, Paul De Bank, *University of Bath*

(Embargoed awaiting approval by funding partner - Cannot be published online or elsewhere in current state and will be updated following approval).

To accurately model resuspension of aerosol particles from real-world surfaces, the interaction between surface topography and particle-surface adhesive forces must be understood. In “Rock’n’Roll” models for resuspension, the effect of surface roughness on particle adhesion is implemented via a geometric factor containing: the radii of particles, and the distance between asperities on which a particle is sat. This factor is frequently fixed at a single value, despite expected variation, and does not consider nanoscale roughness, which is a key factor in particle-surface adhesive forces.

To assess the impact of geometric factor on particle adhesion and specifically adhesive force, direct laser writing and sputter coating can be used to produce a range of surfaces with consistent asperity widths and, by pairing with glass beads of specific size, controllable geometric factor. For each surface-particle pair, colloidal probe atomic force microscopy can then be performed to measure the distribution of particle-surface adhesive and produce force maps. Alongside this, the distribution of geometric factors of real-world materials may be estimated via topographical atomic force microscopy and simulated particle contact. For both real-world and designed surfaces, nanoscale roughness may be altered via coating under different conditions and different methods, including spin coating and thermal evaporation.

Ultimately, by comparison of adhesive force distributions on idealised and real-world materials, with varied nanoscale roughness, and with a range of particle sizes, the suitability of implementing surface roughness via geometric factors when modelling particle adhesion will be reported and potential improvements will be discussed.

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2AP.17

Evaluation of Particle Transport and Concentration Uniformity in Multi-Bend Duct Flows. LEANDER TENBARGE, Aayushi Bohrey, Bernard Olson, Austin Andrews, *Tennessee Technological University*

Understanding particle transport and mixing in curved duct flows is essential for predicting biases in aerosol sampling systems used for combustion-emissions monitoring, where hot exhaust gases must be rapidly diluted and cooled to control aerosol formation. In dilution-based sampling configurations, particle inertia and flow non-uniformity can produce spatially biased concentration fields at the sampling location, leading to inaccurate measurements of particulate emissions. In this work, computational fluid dynamics (CFD) coupled with Lagrangian particle trajectory calculations are used to characterize particle transport in turbulent dilution tunnel systems with multiple bends consisting of 90-degree elbow transitions. Simulations are performed across a range of geometries (6–12 in. diameter) and flow conditions spanning Reynolds numbers of $\sim 4\times10^4$ to 1.6×10^5, with particle diameters from 0.1–10 µm. Results show that curvature-induced secondary flows (Dean vortices), together with flow separation downstream of bends, produce laterally biased particle concentration fields at the sampling plane. To quantify this behavior, a uniformity metric based on the second moment of the concentration distribution (coefficient of variation) is introduced. Although Dean number is commonly used to characterize curvature effects, its ability to predict particle concentration uniformity across tunnel systems with varying tunnel diameters, bend radius and flow rates remains uncertain. Preliminary simulations show a transition in concentration uniformity is observed at a critical Dean number ($De \approx 4\times10^4–5\times10^4$), above which particle distributions become strongly asymmetric, with local concentrations differing by up to a factor of two across the duct. These findings indicate that Dean number provides a useful scaling parameter for predicting sampling non-uniformity and may be used to guide the design of improved mixing and sampling configurations used in duct-based sampling systems.

2AP.18

Influence of Water Composition on Aerosol Emission Through Bubble Bursting: Using Laboratory Experiments to Link Measurements of Water, Bubbles, and Aerosols for Solutions of Varied Contamination. MEGAN MAZZATENTA, Samuel M. Koblensky, Luc Deike, Kimberly Prather, *University of California San Diego*

Bubbles formed by breaking waves or riverine turbulence rise to the water surface where they cluster and burst, emitting aerosols into the atmosphere and thereby modulating the link between the physicochemistry of the water solution and resulting aerosols, with consequences for both climate and public health. The need for development of mechanistic emission functions in climate and air quality models motivates controlled experiments studying how complex seawater solutions affect aerosol emission by clusters of bursting bubbles. Using a bubbling tank experiment with solutions of artificial seawater and the surfactant sodium dodecyl sulfate (SDS), we investigate the influence of organics on the mechanisms of bubble bursting, namely film drop and jet drop production, in controlled solutions. We show that the number of emitted submicron aerosols, linked to film drop production, increases with added SDS by up to a factor 4 at an optimal concentration, while production of supermicron aerosols emitted through jet drop production is shut down. The physical production mechanism and seawater composition influence not only the number of resulting aerosols, but also their composition, which impacts both the aerosols' role in the atmosphere and associated health risks upon inhalation. We therefore introduce a second laboratory setup which adds measurements of aerosol composition and single particle mixing state for aerosols generated by bubble bursting in filtered seawater solutions. To consider the health implications, we use the same setup to study bubble-mediated aerosolization in solutions containing a small percentage of water collected from the Saturn Boulevard site along the Tijuana River, contaminated with pollutants from raw sewage. Results from this highly-contaminated solution provide a starting point to develop a mechanistic framework using water measurements to predict the size, number, composition, and overall health risks associated with particles aerosolized from the river or coast and spread to nearby communities.

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2AP.19

Effects of Salt and Surfactant on Sea Spray Aerosol Properties. SAMUEL M. KOBLENSKY, Luc Deike, *Princeton University*

Sea spray aerosol (SSA) is generated primarily through droplet production from bursting bubbles at the air-sea interface. The aerosol particles become entrained in the atmosphere, where they may act as cloud condensation nuclei and ice nucleating particles, and can affect the radiative balance. Since the behavior of SSA particles in the atmosphere depends on its chemical properties and morphology, it is important to understand how the local composition of the ocean affects the physicochemical mixing state of the aerosol. We study the production of SSA using a small-scale experimental setup in an enclosed, controlled environment. Rafts of bubbles are generated in a petri dish consisting of different concentrations of salts (NaCl and artificial sea salt) and surfactants (both ionic and non-ionic). Bubble size distributions are measured synchronously with emitted drop size distributions using a scanning mobility particle sizer (SMPS), optical particle sizer (OPS), and custom in-line holographic setup. This setup also enables the collection of dried aerosols for remote analysis. We explore a parameter space of solution conditions and analyze how salts and surfactants affect the size distribution and mixing state of SSA.

2AP.20

Weak, Water-Soluble Brown Carbon at a Petrochemical Complex in Winter: Primary Combustion Controls Absorption While Secondary Organics Dilute It. KYUNGAE SEO, Hwajin Kim, Jaewook Kim, Jihye Moon, Jaewon Seo, *Seoul National University*

Brown carbon (BrC) is poorly characterized in South Korea, and its behavior at heavy-industry sites, where strong primary combustion BrC might be expected, remains undocumented. We present the first integrated optical, chemical characterization of BrC at the Daesan petrochemical industrial complex during winter (December 2023–January 2024), combining a multi-wavelength Aethalometer (AE33), HR-ToF-AMS, and UV–Vis spectrophotometry of water- and methanol-soluble filter extracts. Contrary to expectations, bulk BrC absorption was weak: the mass absorption efficiency (MAE365, water) of 0.55–0.94 $m^2\ gC^{-1}$ was lower than for urban Seoul and Los Angeles. Organic-aerosol mass was dominated (~64%) by secondary oxygenated factors (AMS-PMF) that absorb weakly per unit mass and dilute the bulk MAE. In contrast, when BrC absorption (5.8 Mm^{-1} at 370 nm; ~34% of carbonaceous absorption; AAE 1.4–1.6) was decomposed against PMF factors, solid-fuel organic aerosol, likely regional biomass and coal burning rather than the petrochemical process itself, was the most absorptive factor per unit mass and the largest identified contributor, though a large unattributed baseline indicates additional, possibly secondary, absorbers. Absorption at 365 nm correlated with the organic N/C ratio (r = 0.66) and water-soluble organic carbon (r = 0.94), implicating nitrogen-containing chromophores. Because the strongly absorbing fraction is primary combustion while the complex mainly adds weakly absorbing secondary organics, bulk absorptivity is set by the primary to secondary balance, a distinction important for models that treat BrC as a single absorbing species. Using co-located online measurements and photochemical age, we assess the potential for how BrC absorptivity evolves downwind, where secondary formation and photobleaching compete. These results show that a petrochemical complex need not produce strongly absorbing BrC, and that its climate-relevant absorption is governed by combustion sources modulated by secondary processing and aging.

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2AP.21

Microdroplet Characterization of Surface-Active Tire-Derived Organic Pollutants with a Quadrupole Electrodynamic Trap.
CECILIA PILON, Alexandra Deal, *University of Michigan*

Tire-Derived Organic Pollutants have gained increasing environmental concern due to the limited understanding of their physical-chemical properties related to partitioning. N-phenyl-N'-(1,3- dimethylbutyl)-p-phenylenediamine, or 6PPD, is used as a stabilizing additive in tires. 6PPD's primary ozonation product, 6PPD-quinone, has been found in our natural waters at much higher concentrations than its toxicity limit, and it is hazardous with high toxicity to aquatic species. Given that our preliminary surface tension experiments indicate 6PPD-quinone is surface active, interactions at the air-water interface are key to understanding the physicochemical properties and environmental fate of both 6PPD and its transformation products. 6PPD and 6PPD-Q microdroplets are subject to physical and chemical changes caused by semivolatile partitioning and multiphase reactions during transport to aquatic ecosystems. This makes transformation products challenging to isolate by traditional methods, pointing to the utility of single-particle measurements. The Quadrupole Electrodynamic Trap, or QET, is an ideal methodological tool to study this system due to its ability to suspend individual microdroplets in a laboratory setting, controlling their physical properties such as size, charge and relative humidity without requiring deposition onto a substrate. Therefore, in this study, a home-built QET is used to characterize lab-generated 6PPD and 6PPD-Q microdroplets. By studying physiochemical changes in these microdroplets over time, the utility of the QET is shown by gaining a more comprehensive understanding of their physical characteristics at the single particle level. Additionally, the microdroplet surface has been shown to act as a microreactor, accelerating chemical transformations at the microdroplet interface. However, the mechanism by which this distinctive triggering or accelerating is driven is highly debated. In particular, this study allows for the monitoring of charge and curvature effects on 6PPD derived chemical transformations.

2AP.23

Metal Rain: How Satellite Re-entry Aerosols Could Warm the Stratosphere.
PRABHAV UPADHYAY, Sandro Vattioni, Jian Huang, Wei Su, Timofei Sukhodolov, John Dykema, Jan Sedlacek, Taveen S. Kapoor, Xinhua Liang, Rohan Mishra, Rajan K. Chakrabarty, *Washington University in St. Louis*

The rapid expansion of low Earth orbit (LEO) satellite constellations is expected to increase the mass of material re-entering Earth's atmosphere as much as twenty-fold over the coming decades, approaching 200 Gg/yr. During atmospheric re-entry, satellites undergo aerodynamic heating, fragmentation, and ablation, converting structural metals into vapor and submicron aerosol particles that are injected directly into the upper atmosphere. Aluminum, which constitutes a major fraction of satellite mass, undergoes rapid but often incomplete oxidation during ablation, producing partially oxidized Al-core Al_2O_3-shell aerosols alongside fully oxidized alumina aerosols. These core-shell particles exhibit strong shortwave light absorption, distinct from purely light-scattering alumina. This could have implications for stratospheric radiative balance and ozone chemistry that remain poorly understood.

Here, we investigate the influence of satellite re-entry aerosols on stratospheric temperature and ozone using a global chemistry-climate model, prescribing aluminum-containing aerosol injections into the upper atmosphere under future emission scenarios. Simulations examine the resulting changes in aerosol burden, radiative heating rates, stratospheric temperature, and ozone relative to a present-day baseline, with the radiative response evaluated using optical properties representative of partially oxidized Al/Al_2O_3 re-entry particles.

Preliminary results indicate that projected re-entry emissions produce localized stratospheric heating and perturbations in ozone, with magnitude and spatial distribution depending on emission rates and the assumed metallic-core fraction from incomplete oxidation. Incorporating anthropogenic space-derived aerosols into assessments of stratospheric composition and climate will be increasingly important as re-entry rates grow, and for evaluating the environmental sustainability of the expanding space sector.

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2BA.2

Disentangling the Factors Controlling the Emission of Bioparticles That Act as Ice Nucleating Particles. GAVIN CORNWELL, Shreya Joshi, *Pacific Northwest National Laboratory*

Ice nucleating particles (INPs) affect cloud radiative properties and precipitation through their ability to initiate primary ice formation, which is a critical step required for cloud microphysical processes that govern cloud phase. Bioparticles (particles derived from biological organisms such as bacteria, pollen, and fungal spores) are thought to be key contributors to ambient INP populations in certain regions due to their high ice nucleation activity at warm temperatures. However, bio-INPs are currently not included in most global and regional models. Despite their importance, the identities of and factors controlling the emission of bio-INPs are not well understood.

We propose a three-part plan to address these issues: (1) develop machine learning (ML) tools to classify particles; (2) collect long-term measurements of bioparticles and INPs at a remote vegetated site in the southeastern United States; and (3) use ML to derive quantitative relationships between bio-INP emissions and environmental factors. The process knowledge developed from this project will be used to improve the emission schemes of bio-INPs, leading to increased accuracy in INP predictions by Earth system models. I will present an overview of this plan, along with initial results.

2BA.3

A Hierarchical Machine Learning Framework for Atmospheric Bioparticle Detection at Bankhead National Forest. SHREYA JOSHI, Nurun Nahar Lata, Ashfiqur Rahman, Zezhen Cheng, Swarup China, Gavin Cornwell, *Pacific Northwest National Laboratory*

Biological aerosol particles play a key role in the atmosphere by acting as ice-nucleating particles (INPs), thereby influencing cloud radiative properties and precipitation. However, their behavior in the atmosphere remains poorly constrained due to their low abundance, compositional diversity, and the complex environmental factors that control their emissions.

In this study, we deploy the Wideband Integrated Bioaerosol Sensor (WIBS) at Bankhead National Forest (BNF) to investigate the environmental drivers of bioparticle emissions and their impacts on cloud phase. To improve bioaerosol detection, we developed a supervised machine-learning model that estimates bioparticle abundance using single-particle fluorescence and morphology measurements from WIBS. The model was trained using laboratory-generated bioaerosols and mineral dust particles.

We further developed a secondary algorithm for qualitative identification of non-fluorescent bioaerosols, including biomass-burning aerosols. In addition, an unsupervised clustering approach was implemented to distinguish whole pollen grains from fragmented pollen produced through mechanical stress or hydration processes. To evaluate the framework's performance, we applied the clustering method to data collected during an intense biomass-burning event at the PNNL Richland campus and during a two-week winter measurement campaign at BNF, where we also collected microscopy samples. These were analyzed using computer-controlled SEM-EDX to identify particle types in the region and provide an independent check on WIBS-based classification.

By combining supervised fluorescence-based classification with unsupervised structural differentiation, the proposed framework enables real-time, source-informed, particle-level characterization of atmospheric bioparticles. This advancement will improves our ability to assess their contributions to INP populations and their broader influence on cloud microphysical processes.

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2BA.5

Characteristics of Occupational Disease Cases Associated with Bioaerosol Exposure. YOULIM LEE, *Institute of Occupational and Environment, KCOMWEL*

Bioaerosols are airborne biological agents that can penetrate the alveolar region and induce adverse health outcomes, including infectious diseases, hypersensitivity pneumonitis (HP), and chronic obstructive pulmonary disease (COPD). In South Korea, occupational exposure assessment for bioaerosols remains limited because occupational exposure limits have not been established. This study investigated occupational disease cases associated with bioaerosol exposure to characterize exposure sources and related health effects.

Between 2007 and 2025, 6,508 cases were referred to the Institute of Occupational and Environment (IOE) for epidemiological investigation following applications for industrial accident compensation to the Korea Workers' Compensation and Welfare Service. Among these, 68 cases involving infectious diseases or industries with potential bioaerosol exposure were initially screened. 17 work-related cases were selected for detailed analysis of exposure characteristics and health outcomes.

Among the 17 analyzed cases, 12 were attributed to direct bioaerosol exposure, 3 involved aggravation of pre-existing diseases, and 2 were mixed exposure cases involving inorganic aerosols such as coal dust and silica. Major bioaerosol agents included Mycobacterium tuberculosis, Klebsiella pneumoniae, fungi/mycotoxins, and endotoxins. In addition to recognized high-risk sectors such as healthcare services, waste treatment, and agriculture/livestock industries, microorganisms were also identified in water-soluble metalworking fluids, suggesting that manufacturing environments may contribute to disease occurrence and exacerbation. Although quantitative historical exposure data were limited, work-relatedness was supported by temporal associations between aerosol-generating processes and disease onset, along with evidence of potential workplace exposure.

This study confirms that infectious bioaerosols can induce acute exacerbation even after short-term exposure, while non-infectious agents may aggravate pre-existing diseases. As disease patterns vary by particle size and biological activity, aerosol control strategies must extend beyond conventional total dust management to incorporate specific biological characteristics. Future research should focus on establishing monitoring strategies for environments involving mixed aerosol exposures.

2BA.6

Mapping Ecosystem Biodiversity Using Airborne Environmental DNA. SHALLON MUTSA JOZI, Amira Hansch, Nicolas Gustafson, Roger Schürch, Scotty Yang, Gabriel Isaacman-VanWertz, *Virginia Tech*

Insects provide services worth billions of dollars each year, such as pollination, nutrient cycling, and contributing to soil health. Alarmingly, insects are sharply declining, with up to 75% of insect bio-mass lost in the past three decades. Current methods to study these insect declines are labor intensive because they involve manual work (trapping and insect ID) for spatially resolved measurements. We developed simple, portable devices that can sample with limited operator presence to enable temporally and/or spatially resolved measurements. These new portable and programmable samplers enable simultaneous collection of samples across a spatially distributed network, which we demonstrate here as a method to sample airborne DNA. In this presentation, we assess how efficient low-volume airborne eDNA samplers are for detecting arthropods and demonstrate their potential for biodiversity monitoring. Using both broad arthropod metabarcoding primers and species-specific assays, we generate presence/absence data across multiple sampling events. Although airborne DNA is consistently captured, we find that concentrations are low, the DNA is highly fragmented, and non-target amplification is common. These patterns reflect the stochastic nature of airborne eDNA capture and the heterogeneous distribution of biological material in the environment, underscoring the need for careful primer selection, replication, and validation when targeting arthropods. We further evaluate how sampler flow rate affects DNA yield and whether increasing flow introduces tradeoffs such as greater DNA fragmentation despite higher collection efficiency, and we demonstrate that replication substantially improves data reliability. Together, these results highlight key methodological considerations for integrating airborne eDNA into biodiversity monitoring frameworks.

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2BA.7

Quantifying Respiratory Particle Emission Rates for Singers and Non-Singers. MAHENDER SINGH RAWAT, Dinushani Senarathna, Byron Erath, Sumona Mondal, Sarah K. Sirsat, Andrea Ferro, *Clarkson University*

The rate of respiratory aerosol emissions and particle size distributions vary based on respiratory activities such as speaking, coughing, singing, talking, breathing, and shouting. Studies report that these activities generate up to thousands of particles per second and that singers generate higher respiratory aerosol concentrations than non-singers.

To investigate why singers produce more particles, we conducted a study with 47 participants, 45 of whom completed the experimental protocol (13 singers and 32 non-singers). We additionally asked a subset of the 45 singers (n=8) and non-singers (n=8) to perform the open vowel /a/ phonation for two additional conditions: 1) supported breath control (i.e., diaphragmatic breathing); and 2) unsupported breath control.

Aerosol samples were collected by having subjects phonate into a funnel that was connected to the TSI Model 3321 Aerodynamic Particle Sizer (APS) (Shoreview, MN, USA), which was placed inside a laminar flow hood. A Logitech Blue SNOWBALL iCE microphone and a sound pressure level (SPL) meter were used to obtain the audio recordings and corresponding dB measurements.

The results indicate that singers generate 20-70% more particles per second than non-singers, depending on the vocal activity. We also found that when using supported breath control during vocalization, singers emitted more particles per second than when using unsupported breath control. Our findings support the hypothesis that increased tidal volume, as naturally occurs in singers who use breath support, gives rise to increased respiratory particle production.

2BA.9

Characterizing Emissions of Biotic Inoculant Containing Aerosol from Ultrasonic Devices: One Element of a System to Inhibit Mold Growth in Buildings. EM NORTMANN, Clara Eichler, Megan Lott, Glenn Morrison, Joe Brown, Rachel Noble, Sherlynette Pérez Castro, Nicole Rockey, Claudia Gunsch, David Singleton, Gavin Duffy, Boyuan Chen, Yanbaihui Liu, Barbara Turpin, *University of North Carolina at Chapel Hill*

Fungal growth and dampness in the residential built environment are associated with a range of respiratory health impacts, such as asthma exacerbation, coughing and wheezing, and upper respiratory tract symptoms. These health effects are of particular importance as 10-20% of U.S. residences are affected by mold and individuals spend up to 90% of their time indoors. Chemical cleaners, while effective in removing mold, can lead to unintended microbial shifts, including rapid mold recolonization. To address this problem, we are developing an automated, sensor-based mold remediation system that integrates real-time sensing of microbial volatile organic compound (MVOC) emissions with the targeted delivery of an engineered anti-fungal biotic inoculant. This remediation system aims to promote an indoor microbiome resilient to mold growth. This poster focuses on aerosolization of the biotic inoculant as a mechanism to deliver it to indoor surfaces, seen and unseen, in unoccupied spaces. We conducted experiments in an 8-m^3, continuously-mixed chamber operating at air change rates of 6.0-11.5 h^{-1} and equipped with an optical particle counter to capture particle mass concentrations and particle size distributions in real time. Using a simplified model biotic inoculant with properties representative of the final inoculant, we evaluated four commercially available ultrasonic aerosolization devices under steady-state conditions. Emission rates ranged from 25-567 mg h^{-1} and exhibited generally bimodal particle size distributions, with mass median diameters near 0.5 µm and 1.6 µm. These results support the selection of an optimal device for deployment in an unoccupied test house to assess inoculant distribution and surface deposition. The emission rates will further inform a multi-zone mass-balance model to predict inoculant transport and deposition under varying indoor conditions.

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2BA.10

Development of a 3D Printed Lightweight Wetted Wall Cyclone Microsampler for Drones. EDUARDO ESCAMILLA RODRIGUEZ, Maria King, Juan Garcia Lunar, Chloe McWillis, *Texas A&M University*

Wetted Wall Cyclone (WWC) samplers have been widely used for bioaerosol research due to their high efficiency collection while maintaining culturability and infectivity. However, the traditional WWC systems are often large and power intensive, creating challenges for field use. To address this limitation, a compact 3D-printed WWC microsampler has been developed for bioaerosol collection and future drone sampling applications. The sampler measures 4.5 x 4.4 x 4.85 in. A previous cyclone body was miniaturized by Stokes scaling and used for a new cyclone design to preserve particle collection capabilities while reducing the overall size. The new sampler aims for a sampling flow rate of 100 L/min, which allows for lower power requirements. The microsampler is equipped with the 3D printed resin cyclone body, a compact peristaltic and liquid injection pump, a blower, and a sample collection vial. The sampler is controlled by a Raspberry Pi Pico 2W microcontroller with a RYLR998 Long Range (LoRa) module attached, allowing for remote control and monitoring. Performance testing is conducted using polystyrene latex (PSL) particles over a wide range of diameters to evaluate particle capture efficiency and determine the collection efficiency curve and cut point diameter of the microsampler. Additional trials with the microcollector equipped with a bell-shaped inlet and screen to filter out insects are set up for potential drone mounted sampling applications to address emerging threats to agriculture by monitoring the spread of diseases and infestation including the Avian Influenza and the New World screwworm.

2BA.11

Further Development of a Self-Contained Personal Electrostatic Bioaerosol Sampler (PEBS) for Bioaerosol Collection. TAEWON HAN, Gediminas Mainelis, *Rutgers, The State University of New Jersey*

We continued development of a personal electrostatic bioaerosol sampler (PEBS) to assess exposure to airborne microorganisms across a range of indoor and outdoor environments. PEBS has been designed as a novel, standalone, battery-operated personal sampler. In this system, bioaerosols are drawn into an open-air channel, electrically charged, and then deposited in a removable, reusable cartridge equipped with a hydrophobic collection plate. After the collection, the sampler is opened, the cartridge is removed, and the collected particles are eluted into liquid for analysis. Notably, the cartridge functions as both the sampling chamber and the elution container, eliminating additional transfer steps and minimizing sample loss. We also designed a sampler version in which only a collection plate is removed and eluted, minimizing the elution volume to 0.5 ml and achieving up to a tenfold increase in sample concentration compared to previous PEBS versions. This enhanced concentration capability improves bioaerosol detection limits, allowing for more accurate and rapid monitoring of personal exposure, even at low microorganism concentrations. Additionally, we redesigned the sampler's housing and improved the integration of electronic control components. Sampler's evaluation in the laboratory against established personal samplers when collecting *Staphylococcus epidermidis* bacteria, *Penicillium chrysogenum* spores, and bacteriophage Phi6 at different sampling flow rates (10 and 20 L/min) and sampling durations (10, 60, and 240 min) showed excellent performance, while offering portability and quiet operation. Evaluation of PEBS in the field against the BioSampler and Button aerosol sampler (SKC Inc.) during 240-minute sampling also shows its satisfactory performance. These results demonstrate the potential of PEBS as an efficient tool for personal bioaerosol exposure assessment.

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2BA.12

Weekly HVAC Filter Surveillance of Influenza a Viruses in University Settings: Linking HVAC Filter Viral Loads to Airborne Viral Concentrations and Infection Risk. ZHOUYUAN WANG, Jade Mitchell, Kaisen Lin, *Michigan State University*

Heating, ventilation, and air conditioning (HVAC) systems continuously process large volumes of indoor air through filters capable of capturing virus-laden particles. Although previous studies demonstrated successful detection of respiratory viruses in HVAC filters, most relied on monthly sampling intervals with limited temporal resolution and focused primarily on qualitative detection rather than quantitative infection risk assessment. This study evaluated the feasibility of weekly HVAC filter surveillance for influenza A virus detection in university lecture rooms and integrated quantitative microbial risk assessment (QMRA) modeling to estimate airborne viral concentrations and infection risks.

Three air handling units (AHU-5, AHU-6, AHU-108) serving individual lecture rooms in two university buildings were monitored from February to March 2025. MERV13 pleated filters were collected weekly, and airflow rates were continuously recorded. For each filter, three dust samples (~0.05 g each) were extracted and analyzed via triplicate RT-qPCR assays.

Peak detection occurred during Week 2, when 89% of filter samples tested positive across all AHUs, suggesting high viral prevalence within the monitored spaces. Viral loads in filter dust ranged from 3.0×10^4 to 5.1×10^5 gc/g dust. Estimated airborne viral concentrations varied among AHUs. AHU-5 showed the highest variability (mean: 4.1 gc/m^3, range: 0.15-76.19 gc/m^3), AHU-6 demonstrated consistent concentrations (mean: 1.0 gc/m^3), and AHU-108 exhibited moderate variability (mean: 0.7 gc/m^3). QMRA modeling revealed extremely low long-range airborne infection risks (on the order of 10^{-6} or lower) even during peak detection periods, although risk increased linearly with exposure duration.

These findings demonstrate that weekly HVAC filter surveillance can provide temporally resolved monitoring of influenza A virus in university settings. The integration of filter-based surveillance and QMRA modeling highlights the potential of HVAC filter analysis as a non-invasive tool for respiratory virus monitoring and indoor exposure assessment.

2BA.14

Real-Time Fluorescence Signatures of Viable and Inactivated Airborne Bacteria. JOOWON LEE, Chunxu Huang, Brianna Corman, Bartek Rajwa, Nusrat Jung, *Purdue University*

Real-time fluorescence detection systems are critical for maintaining air quality in pharmaceutical cleanrooms and controlled atmospheres where airborne bacterial contamination poses operational risks. Current methods require improved understanding of how inactivation treatments affect bacterial fluorescence signatures to ensure accurate classification. This study evaluated fluorescence signatures of viable and inactivated airborne bacteria using real-time measurements to characterize treatment-dependent variations for enhanced bacterial aerosol monitoring applications. A controlled aseptic indoor chamber environment was established and maintained below ISO Class 5 cleanliness criteria to investigate bacterial fluorescence characteristics under well-defined conditions. Escherichia coli (ATCC 12228) suspensions prepared in 0.9% NaCl were aerosolized using a Sparging Liquid Aerosol Generator (SLAG). Real-time fluorescence signature measurements were performed using a Wideband Integrated Bioaerosol Sensor (WIBS-NEO) during 20-minute aerosol injection periods. Fluorescence intensity distributions were compared between viable and inactivated bacterial states, including UV-, autoclave-, and chemically treated samples. Distinct shifts in fluorescence signatures were observed depending on inactivation method. UV- and autoclave-treated samples exhibited reduced contributions in high-intensity fluorescence regions compared to viable bacteria, indicating clear differentiation in fluorescence characteristics. In contrast, chemically treated samples produced fluorescence signatures more similar to viable conditions, with limited separation observed between viable and inactivated states. These results demonstrate that real-time fluorescence signatures are strongly influenced by inactivation method, highlighting the importance of treatment-dependent interpretation for airborne bacterial detection. Findings provide insights for optimizing monitoring protocols in pharmaceutical manufacturing and cleanroom operations requiring stringent microbial control.

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2BA.16

Vertically-Resolved Measurements of Bioaerosol and Seasonal Aerosol Composition at Bankhead National Forest. MARIA A. ZAWADOWICZ, Chongai Kuang, Andrei Vakhtin, Tamanna Subba, Shawn Serbin, Darielle Dexheimer, Casey Longbottom, Gabrielle Whitson, Carlos Ruiz, Jessie Creamean, Zezhen Cheng, Gregory W. Vandergrift, Ashfiqur Rahman, Nurun Nahar Lata, Swarup China, *Brookhaven National Laboratory*

We present two years of spring–summer observations from the Bankhead National Forest (BNF) Atmospheric Radiation Measurement (ARM) site aimed at characterizing near-surface and vertically resolved bioaerosol populations in a forested southeastern U.S. environment. Measurements were conducted using a Wideband Integrated Bioaerosol Sensor (WIBS) deployed both at the surface and on the tethered balloon system (TBS), providing complementary constraints on fluorescent biological aerosol particle abundance, size, fluorescence characteristics, and vertical structure within and above the forest canopy. The combined surface and TBS measurements enable evaluation of diurnal and seasonal variability in bioaerosol emissions, boundary-layer mixing, and transport, including the degree to which surface observations represent aerosol populations aloft during biologically active spring and summertime periods. To place the bioaerosol observations in broader aerosol chemical context, we also analyze concurrent spring–summer submicron aerosol composition using aerosol chemical speciation monitor (ACSM) positive matrix factorization (PMF). This analysis characterizes the seasonal organic aerosol environment and identifies dominant aerosol factors associated with regional background, secondary organic aerosol formation, and other chemically distinct sources that may influence or co-vary with biological particle concentrations. Together, the WIBS surface and TBS measurements, supported by ACSM PMF source-apportionment analysis, provide a vertically resolved view of bioaerosol occurrence at BNF and improve understanding of how biological particles relate to seasonal aerosol composition, forest-atmosphere exchange, and boundary-layer dynamics in a representative southeastern U.S. forest ecosystem.

2BA.17

Microbial Fluctuations and Bioaerosol Concentrations in a Backyard Poultry Coop Before and After Litter Removal. JOHN CATE, Maria King, *Texas A&M University*

As the popularity of backyard poultry farming continues to rise steadily across the United States, an increasing number of homeowners and their neighboring communities face the risk of inadvertent exposure to wind-dispersed bioaerosols. Despite the potential public health implications of this growing agricultural trend, the microbiome composition and concentration of bioaerosols in residential chicken coops remain significantly under-researched. The majority of existing literature focuses heavily on large-scale commercial poultry operations, leaving the specific exposure risks posed by small-scale environments largely undocumented. To address this critical knowledge gap, this study evaluates a free-range residential chicken coop located in Texas. The primary objective is to compare bioaerosol concentrations and microbiome profiles before and after cleaning interventions to accurately delineate environmental fluctuations and assess the efficacy of standard hygiene practices. Air sampling was conducted using two distinct systems to capture a comprehensive aerosol profile: a high-air-volume (400 L/min) wetted wall cyclone bioaerosol collector developed at the Aerosol Technology Laboratory at Texas A&M University, and a dry filter-based BioFlyte® BioCapture™ z720 collector operating at 200 L/min. Recovered bacteria were plated for colony-forming unit (CFU) counts to assess overall viability, while antibacterial resistance was evaluated using the standardized Kirby-Bauer disc diffusion method. The samples were enumerated by quantitative polymerase chain reaction (qPCR) for precise gene copy number (GCN) counts, and deep characterization of the microbiome composition was achieved through Illumina Sequencing. Preliminary observations indicate that airflow patterns within the coop resuspend bacteria, potentially exposing individuals to pathogenic and antibiotic-resistant microorganisms. Ongoing comparative data analysis will quantify the specific reductions in total bioaerosol load and the shifts in microbial diversity detected post-cleaning. Ultimately, this research aims to provide actionable, evidence-based recommendations, such as frequent litter removal and the installation of adequate ventilation, to protect backyard poultry keepers from harmful bioaerosols and mitigate broader community exposure.

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2BA.18

Survival Mechanisms Triggered in Escherichia coli Knockouts by Aerosolization Induced Stress. LEILY KHALEGHI, Maria King, *Texas A&M University*

Indoor airborne pathogens increasingly display antimicrobial resistance (AMR), with the most diverse antimicrobial-resistant populations found in hospitals with high air changes. According to previous studies, indoor environmental factors, particularly airflow pressure, trigger stress responses that incidentally support AMR behavior. Membrane-bound proteins, particularly efflux pumps and mechanosensitive channels (Msc) become activated as a survival mechanism to alleviate pressure caused by aerosolization. The goal of this study was to determine the main factors that trigger responses from the channels using seven *Escherichia coli* knockout strains with various deletions of the large MscL and small MscS channels. The strains were aerosolized using a 6-jet Collison Nebulizer at 20 psi in an experimental chamber to replicate a ventilated room. Testing was conducted for increasing aerosolization times of 5, 10, 20, 30, and 45 minutes. Samples were collected using a wetted wall cyclone bioaerosol collector. Aliquots of each sample were plated on tryptic soy agar, without (control), and with antibiotics including Ampicillin, Chloramphenicol, Gentamycin, Kanamycin, and Tetracycline. A second set of aliquots were grown in liquid media overnight for disk diffusion testing containing eight different antibiotics (Ampicillin, Chloramphenicol, Cefoperazone, Gentamycin, Imipenem, Kanamycin, Sulfamethoxazole-Trimethoprim, and Tetracycline). Culturable counts show that three of the strains, missing either the large or small Msc channel or both, plus the KefA channel that acts as their functional backup, became resistant to both Ampicillin and Kanamycin, particularly at 30 min of aerosolization. The strain missing only MscL and MscS remained susceptible. The Kirby-Bauer data showed that the MscS deletion resulted in resistance to all antibiotics except for Sulfamethoxazole-Trimethoprim and Tetracycline at the 20 min aerosolization period. The tri-channel deletion strain showed resistance to Ampicillin, Cefoperazone, and Tetracycline at 5 min and to Ampicillin, Cefoperazone, Imipenem and Sulfamethoxazole-Trimethoprim at 30 min. The results indicate two different mechanisms, first triggered within a few minutes then after a longer exposure.

2BA.19

Radionuclide Surrogate Particle Resuspension on Surfaces. JUAN GARCIA LUNAR, Stephen King, Joshua Hubbard, Maria King, *Texas A&M University*

Given the growing interest in nuclear technology, it is necessary to understand the mechanisms and frequency of radionuclide spread in the event of a nuclear release incident. Air, water, and animals exposed to radioactive contamination are capable of transporting the nuclei large distances, exposing the environment and human health to a long-lasting hazard. Adhesion strength and resuspension frequency will depend on multiple factors, such as surface material, surface roughness, particle size, and wind velocity. The microscale impact of different parameters was studied through the use of Atomic Force Microscopy (AFM), surface imaging, and Peak Force Quantitative Nanomechanics for local adhesion strength measurements. Particle Image Velocimetry (PIV) and Particle Tracking Velocimetry (PTV) techniques with laser-aided high-speed camera were used to quantify the resuspension frequency of nuclear surrogate particles from settling on various surfaces due to wind exposure, as well as the deposition rate of the particles on the substrate. To characterize behavior over the potential surfaces that radionuclides encounter in a release incident, concrete, stainless steel, vinyl, and turfgrass substrates were tested for resuspension and deposition using a 5 m long experimental setup with a rectangular air duct. Aluminum dioxide and cerium dioxide particles of 1 and 10 micrometer size were deposited on various substrates by gravitational settling on each surface installed in the bottom portion of a 10 cm x 2 cm clear segment of the setup. Particle tracking was used to characterize the initial motion before lift-off, and a particle counter at the end of the wind tunnel to track the resuspended fraction. Injection of particles upstream of the flow and particle tracking using PIV/PTV help identify the interaction of the flow, substrate, and particles that result in deposition of suspended radionuclides.

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2BA.20

No Observable Effect of Singing on Influenza B Virus Shedding in Exhaled Breath. ANNA PULLEY, Madison L. Sawyer, Philippe Lubet, Amrita Mandal, Anamarie LeDuc, Alycia Smith, Kristen K. Coleman, S.-H. Sheldon Tai, Jonathan Vyskocil, Donald K. Milton, *School of Public Health, University of Maryland, College Pk*

Background: In Coleman et al. 2021, singing was associated with increased SARS-CoV-2 aerosol shedding. However, the impact of singing on influenza aerosol shedding is unknown. Here we evaluated the impact of singing on influenza virus aerosol shedding.

Methods: During an influenza transmission trial in February 2026, we sampled exhaled breath aerosols from individuals with community-acquired influenza using the Gesundheit-II (G-II). Each participant provided a 30-minute sample while tidal breathing, coughing spontaneously, and repeating the alphabet at 5-, 15-, and 25-minute time points. They then provided a 15-minute sample while singing continuously. We recorded the number of coughs during each session and decontaminated the G-II with 10% bleach between sessions. We assayed viral load using digital PCR.

Results: We collected 29 sets of breathing and singing samples from 13 Donors. One Donor with an H3N2 infection provided 2 sets of samples while 12 Donors with IBV provided 27 sets of samples. We detected viral RNA in 4 (14%) of the breathing/alphabet and 10 (34%) singing session coarse aerosol (>5µm) samples. For fine aerosols (≤5µm), 13 (45%) of the breathing/alphabet and 14 (48%) of singing samples contained detectable viral RNA. Among positive samples, RNA copy numbers in coarse aerosol fraction (107 to 1,707) were less than in the fine fraction (106 to 200,557, $p<0.001$). Total viral RNA copy numbers in positive breathing/alphabet samples (106 to 201,937) were not significantly different than in singing samples (110 to 31,647, $p=0.30$). The effect of cough frequency is pending.

Conclusions: As previously observed, viral aerosol shedding was dominated by the fine aerosol fraction. While singing primarily increased shedding in the coarse fraction, unlike with SARS-CoV-2, it did not appear to impact total influenza B aerosol shedding. Future studies will be required to assess the impact of singing on influenza A virus aerosol shedding.

2BA.21

Addressing the Gas Phase Transition of Protein Nanocages. LUIS-JAVIER PEREZ-LORENZO, Preston Dennett, *NanoEngineering Corporation*

High-resolution Differential Mobility Analysis (ES-DMA) was used to resolve gas-phase mobility conformer partitioning of protein nanocages across a controlled range of sheath / carrier gas relative humidities (RH) from ∼5–80%. Empty adeno-associated virus (AAV) capsids, despite being monodisperse in mass, generate narrow multi-modal peak profiles when aerosolized and analyzed by ES-DMA in a dry atmosphere (RH<5%), producing three dominant species at approximately ∼23.5 nm, ∼24 nm, and ∼26 nm. Increasing water-vapor content of the sheath / carrier gas drives a progressive redistribution of the mobility spectra into the most compact ∼23 nm form. Sensitivity to RH% shows some variation among AAV serotypes, with AAV9 showing complete conversion to a single 23.5nm peak at ∼40% whilst AAV5 requires ∼70% for equivalent conversion. Genome-containing AAV capsids, by contrast, produce single peak profiles with mobility diameters correlating with the underlying encapsidated genome length.

Both empty and full AAV particles additionally display a gradual monotonic growth in mobility diameters with increasing vapor pressure, as reported previously for other protein ions. However, at a threshold near-saturation R.H. (80...90%), both empty and full AAV capsids exhibit a discrete transition in mobility to yield single highly monodisperse populations of exclusively the largest (∼26nm) form. Notably, under these conditions the empty and full AAV preparations exhibit barely measurable (∼0.1 nm) differences due to underlying genome content, presumably representing the more native, highly hydrated conformational state of the particles. Similar observations are reported for apo-ferritin, indicating that humidity-controlled high-resolution ES-DMA can access and quantify both maximally and minimally compacted conformers of large cage like protein assemblies. This effect is further exploited in a variable humidity tandem DMA setup in order to resolve empty AAV particles occluded by high concentrations of obscurants like those present during viral manufacturing.

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2BA.22

Understanding the Size and Prevalence of Respiratory Viruses in Hospital Settings. Kerry Kelly, MD. TANVIR AHMED, Kamaljeet Kaur, Elizabeth Myers, Darrah Sleeth, Selah Willis, Oscar Ticas, Annalyn Jensen, Hunter Esplin, Chase Crimmins, Rachael Jones, Kristi Warren, *University of Utah*

Respiratory viruses, such as severe acute respiratory syndrome coronavirus (SARS-CoV), Middle East respiratory syndrome coronavirus, and seasonal influenza, are responsible for substantial cases of severe illnesses and death. For example, seasonal influenza epidemics result in approximately 3 to 5 million cases of severe illness and 290,000 to 650,000 respiratory deaths annually. Front-line workers can be particularly at risk for respiratory viruses; however, determining the size and viability of bioaerosols containing respiratory viruses remains a challenge. Although collecting airborne-virus genetic material is relatively straightforward, determining whether a bioaerosol contains viable virus is much more challenging because viruses can become inactive during sampling. In this study we use a novel instrumentation, the biocasade-viable virus aerosol sampler (BC-VIVAS), to understand the frequency, the size, and the viability of four respiratory viruses (influenza A, influenza B, RSV, and SARS-CoV2) in medical settings. The BC is a 3-stage planar cascade impactor that gently collects airborne particles through impaction into a liquid medium. It separates aerosol samples into three size fractions, > 10 µm, 4 - 10 µm, and 1.5 - 4 µm. The VIVAS collects aerosols using laminar-flow water condensation to enlarge and collect aerosols smaller than 1.5 µm in diameter (when integrated with the BC), which are then captured in a liquid medium. We collected aerosol samples during the winter season of 2024/25 and 2025/26 in four locations: 1) the dental school patient bay (with 40 patient chairs and numerous aerosol-generating procedures), 2) the medical intensive care unit, 3) the pulmonary unit, and 4) the waiting room of the emergency department. Our results from 2024/25show that approximately 10% of the samples from the pulmonary unit and emergency department contained genetic material for SARS-CoV2 or influenza A or B. All of the genetic material occurred in the same size bin. Preliminary results for the 2025/26 season suggested that much lower prevalence of viruses.

2BA.23

Evaluating the Size Selectivity and Impact of Collection Media Evaporation on BC-VIVAS Performance. MD. TANVIR AHMED, Kamaljeet Kaur, Kerry Kelly, *University of Utah*

This study evaluates BC-VIVAS's (BioCascade - Viable Virus Aerosol Sampler) size selectivity and the effect of collection media evaporation on stage-specific collection efficiency using monodisperse fluorescent polystyrene latex (PSL) microspheres. The BC-VIVAS is designed to collect bioaerosols directly into collection media in four aerodynamic diameter stages: >10 µm, 4–10 µm, 1.5–4 µm, and <1.5 µm. When 3mL of collection media in each stage, the results indicate that the BC-VIVAS demonstrated effective size segregation, with 84% of 2 µm particles recovered in the 1.5–4 µm stage and 92% of 6 µm particles recovered in the 4–10 µm stage. Particles larger than 10 µm were not efficiently collected, likely due to losses within the aerosol generation and delivery system. The BC's collection efficiency was relatively robust to collection media evaporation, with the exception of 1.5–4 µm stage. While the collection efficiency in 4–10 µm stage remained stable, near 100% across liquid volumes from 4 mL to 1 mL in petri dish, the 1.5–4 µm stage exhibited sensitivity to reduced liquid levels. The fully assembled BC maintained ~93% collection efficiency in the 1.5–4 µm stage at 1 mL when upstream stages contained 3 mL of liquid. However, when all stages operated at 1 mL, collection efficiency decreased to ~83% in the 1.5–4 µm stage, indicating that performance depends on maintaining sufficient liquid volume throughout the system. Overall, these findings suggest that maintaining collection volume of approximately 2-4 mL per stage is important for achieving consistent capture efficiency (>90%).

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2BA.24

Virus Detection in Indoor Environments: Linking Antibody- and PCR-based Measurements to Infectivity. EMAD SANEI, Ke Zhang, Krista Wigginton, *University of Michigan*

Indoor virus surveillance provides early insight into viral circulation and exposure risks, supporting timely public health interventions in shared indoor environments. Because direct infectivity measurements are often limited by assay sensitivity, surveillance commonly relies on polymerase chain reaction (PCR)- or antibody-based detection. This study evaluates virus detection on indoor surfaces by examining how antibody- and genome-based signals relate to infectivity. Although PCR sensitively detects viral genetic material, it may not reflect a loss of infectivity. In contrast, protein-based methods such as enzyme-linked immunosorbent assay (ELISA) may provide a more functionally relevant signal by targeting structural components of intact viruses.

Here, MS2 bacteriophage was used as a model virus to investigate its persistence on surfaces under controlled environmental conditions, including low, intermediate, and high relative humidity (RH) levels, and at different initial MS2 concentrations over time. Viral decay was measured at multiple time points using ELISA and PCR, while the plaque assay served as the reference method for infectious virus recovery. In addition to comparing antibody-, genome-, and infectivity-based measurements, we examined whether antibody selection and ELISA assay configuration influenced the interpretation of viral decay kinetics.

ELISA responses declined more slowly than plaque assay–measured infectivity but more rapidly than PCR signals, which remained relatively stable. These findings suggest that protein-based detection may capture functional changes in viral integrity more effectively than genome-based measurements alone. MS2 persistence varied with relative humidity and initial virus concentration, demonstrating that environmental and experimental conditions influenced decay behavior. However, agreement between ELISA and plaque assay depended on both the antibody used and the relative humidity condition, revealing important differences in assay performance and interpretation. These results highlight the limitations of relying solely on viral genome detection and demonstrate the potential of antibody-based measurements as indicators of infectious virus persistence on indoor surfaces.

2BA.25

Health Risk Assessment of Indoor Airborne Bioaerosol Exposure in Selected Preschools in Selangor, Malaysia. Juliana Jalaludin, Nur Syaidatul Aneesha Mat Sanusi, Khairul Nizam Mohd, ANIL NAMDEO, Mohd Nasir Mohd Desa, *Northumbria University, Newcastle, UK*

Introduction: Indoor Air Quality (IAQ) is a critical determinant of health in preschools, where high occupancy and frequent physical activity increase children's exposure to airborne bioaerosols. Preschool children are particularly vulnerable due to their developing respiratory systems and higher breathing rates.

Objective: This study aimed to assess the health risks associated with indoor airborne bioaerosol exposure among children attending selected preschools in urban and suburban areas of Selangor.

Methods: A cross-sectional study was conducted among 142 preschool children aged 4–6 years in urban and suburban areas of Selangor. Data on sociodemographic characteristics and current respiratory symptoms were collected using adapted questionnaires from the American Thoracic Society (ATS-78-C) and the International Study of Asthma and Allergies in Childhood (ISAAC). Indoor air quality parameters measured included temperature, relative humidity, $PM_{2.5}$, PM_{10}, CO_2, total bacterial count (TBC), and total fungal count (TFC).

Results: Urban preschools recorded significantly higher concentrations of $PM_{2.5}$, PM_{10}, and CO_2 ($p < 0.001$), while suburban preschools exhibited higher TBC and TFC levels; however, these differences were not statistically significant ($p > 0.05$). Respiratory symptoms, particularly cough and nasal blockage, were significantly more prevalent among children in urban preschools ($p < 0.05$). Staphylococcus aureus and Aspergillus spp. were the dominant microbial species identified. Multivariate analysis indicated that bacterial and fungal concentrations were significantly associated with respiratory symptoms. All calculated Hazard Quotients (HQs) for bacterial and fungal exposure were below 1.0.

Conclusion: Although the Hazard Quotients suggest no significant non-carcinogenic health risk, the observed associations between indoor air pollutants and respiratory symptoms underscore the need for mitigation strategies to reduce bioaerosol exposure in preschool environments.

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2BA.26

Real-Time Pollen and Fungal Spore Measurements with the SwisensPoleno Bioaerosol Monitor. Tianyu Cen, Nicolas Bruffaerts, Stefan Horender, Elias Graf, Benoit Crouzy, Sophie Erb, KONSTANTINA VASILATOU, *Federal Institute of Metrology METAS*

Bioaerosols are ubiquitous in the atmosphere, although their concentration and composition can vary significantly in time and by location. Thanks to recent advancements in automated bioaerosol monitoring, new instruments that combine imaging and/or fluorescence spectroscopy with machine learning for real-time species classification have been commercialized. However, as these instruments often rely on non-interpretable "black-box" models, the influence of environmental stressors on the classification accuracy remains insufficiently characterized. In this work, we developed an integrated experimental platform capable of real-time bioaerosol generation, atmospheric aging, and continuous monitoring within a laboratory setting.

Measurements were performed with the SwisensPoleno Jupiter bioaerosol monitor (Swisens AG) equipped with the SWS 2025 classification algorithm. For pollen (Betula spp. and Olea spp.), analysis of holographic images and laser-induced fluorescence data identified geographical origin as the primary environmental factor of feature shifts and classification variance, surpassing the effects of the different aging processes. These results are in line with past studies on the MeteoSwiss 2022 classification algorithm (Vasilatou et al., 2025). Meanwhile, validation of the new MeteoSwiss 2025 algorithm is currently being performed and preliminary data will also be presented.

For lab-cultivated Alternaria fungal spores, aging at moderate to high relative humidity levels promoted the aerosolization of elongated conidia chains rather than individual spores. This shift toward elongated morphological structures was accompanied by higher absolute fluorescence intensities, leading to a significant difference from the pre-trained feature space and a subsequent reduction in classification accuracy. Moreover, measurements with the SwisensPoleno Jupiter and an aerodynamic particle counter revealed that the aerodynamic diameter of the fungal spores is much smaller than their area-equivalent diameter, leading to a counting efficiency below 10% (compared to approx. 50% for pollen particles).

These findings indicate that robust real-time monitoring requires differentiated strategies for model training, specifically the implementation of regionally specific datasets for pollen and the expansion of fungal reference libraries to include the diverse morphological states, such as spore chains, induced by environmental conditions.

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Vasilatou, K., Giannakoudaki, C., Abt, R., Auderset, K., Crouzy, B., Erb, S., … Horender, S. (2025). Toward Accurate Real-Time Bioaerosol Monitoring in the Particle Size Range 1 µm–70 µm. ACS ES&T Air, 2(12), 2979–2990. https://doi.org/10.1021/acsestair.5c00282

2BA.27

High-Flow Aerosol-to-Microliter Liquid Sampling System for Airborne Pathogen Detection. Li Li, Yi-Bo Zhao, HYUNJOO KIM, Bernard Olson, Christopher J. Hogan, *University of Minnesota*

Detection of airborne pathogens in indoor environments requires sampling of large air volumes because bioaerosol concentrations are typically low. However, continuously collecting airborne particles into liquid samples compatible with downstream molecular analysis remains challenging, as conventional aerosol samplers often require large elution volumes and exhibit limited collection efficiency across relevant particle size ranges. Here, we present an integrated high-flow aerosol-to-hydrosol sampling system. The system consists of a multiplexed virtual impactor (VI) operating at flow rates exceeding 500 LPM, followed by a thermally controlled condensational growth section and a wet cyclone liquid collector. The multiplexed VI progressively concentrates aerosol particles into a low-flow minor stream while maintaining particle transmission across wide size ranges. Concentrated particles are subsequently grown into supermicrometer droplets by condensational growth and collected into liquid volumes of several hundred microliters. The multi-stage VI was evaluated using room-air tests and ASHRAE standard wind tunnel experiments, while the integrated aerosol-to-hydrosol system was calibrated using DNA-functionalized tracer aerosol particles. Aerosol concentration factor, particle transmission efficiency, and aerosol-to-liquid recovery were characterized using synchronized upstream and downstream aerosol measurements together with downstream liquid analysis, including PCR. The system demonstrated stable high-flow operation, efficient aerosol concentration, and successful transfer of bioaerosol particles into compact hydrosol samples suitable for downstream molecular analysis.

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2BA.28

Characterization of PM2.5 and Associated Fungal Bio-Aerosols in Indoor and Outdoor Environments of the Most Populated City of India. JAMSON MASIH, Khatija Atthar, Lorraine Tellis, Sachin Gupta, *Wilson College, Mumbai, India*

Atmospheric particulate matter and bio-aerosols constitute a significant component of air pollution, particularly in rapidly urbanizing coastal areas of India. Fine particulate matter ($PM_{2.5}$ and smaller fractions) is of major concern due to its adverse effects on environmental quality and human health. These particles exhibit complex chemical compositions, including organic compounds, elemental carbon, sulphates, nitrates, and trace metals, which vary spatially and temporally under the influence of meteorological conditions and anthropogenic activities. The present study integrates the monitoring of size-segregated particulate matter and the investigation of associated fungal bioaerosols in both indoor and outdoor environments of Mumbai a Financial capital of India, with a focused assessment in a suburban coastal region (Bandra). Particulate samples across multiple size ranges (>2.5 µm to <0.25 µm) were collected using cascade impactor and MiniVol TAS Airmetrics samplers during 2023–2024, covering different seasons with biweekly sampling. Chemical characterization revealed the presence of elements such as Cu, Al, Ca, K, Si, and S, with elevated Al and Si indicating aluminosilicate sources.

Simultaneously, bioaerosol analysis of $PM_{2.5}$ fractions identified dominant fungal species using MALDI-TOF MS, including Aspergillus niger, Aspergillus sydowii, and Paecilomyces spp. Fungal prevalence was strongly influenced by meteorological parameters, particularly humidity, showing higher concentrations during monsoon and post-monsoon periods. The coastal setting, surrounded by water bodies, further enhanced moisture retention, promoting fungal growth and dispersion. Overall, outdoor particulate concentrations were higher than indoor levels, while bioaerosol abundance demonstrated clear seasonal dependence. The combined physicochemical and biological assessment highlights the importance of integrated air quality studies for better understanding health risks associated with airborne particles and microorganisms in urban environments.

2BA.29

Characterization of Multiple Drug Resistant Bacteria Isolated from Chicken Feather Samples, Prayagraj, India. HARISON MASIH, *SHUATS, (Allahabad) Prayagraj, Uttar Pradesh, India*

Aim of present study is to characterize the multiple drug resistant, bacteria from chicken feather samples which is the most common source of poultry bioaerosol, associated to chicken feather, keratin fragments, dust particles, raw chicken and associated environmental contaminants, these poultry feather source contains multiple chemical residues of synthetic drugs which pose the antimicrobial resistance and increase contamination levels, i.e., a significant global challenge, impacting the human, animals as well as the surrounding environment by multiple dimensions. Estimation of bacteria by serial dilution plate method, plates media (Nutrient agar and MacConkey agar) were incubated at 37 ºC for 24-48 hours and bacterial count was recorded in CFU/ml, isolates were identified by gram's staining, biochemical methods and molecular characterization and antibiotic susceptibility test was performed by Kirby-Bauer disc diffusion method. Bacterial count was recorded of the Nutrient agar and MacConkey agar plates (2.48x 108CFU/ml and 16.2x 107CFU/ml). Out of 60 samples, the total 64 bacterial isolates recorded and predominant incidence percentage of bacterial isolates observed, which were as follows maximum incidence was Escherichia coli (36.66%) and minimum Pseudomonas aeruginosa (5%) respectively. Antibiotics (Vancomycin, Azithromycin, Trimethoprime, Cefepine, Meropenum, Levofloxin, Ampicillin and Cefoxitin) susceptibility test was performed against the bacterial isolates and zone of inhibition measured and results were interpreted, Gram positive bacteria were found to be multi-drug resistant over the gram negative bacteria against above antibiotics. Conclusion: The bacterial isolates showed difference in the sensitivity against different antibiotics, Escherichia coli, Bacillus spp., and Pseudomonas aeruginosa, Salmonella spp., Staphylococcus spp. and Pseudomonas aeruginosa were found to be multi-drug resistance pathogens; these bioaerosols can lead to respiratory infections in poultry farm and slaughterhouse workers. Thus the study indicated that the MDR pathogens can cause various health implications.

Keywords: Characterization, antibiotic resistant bacteria, chicken feather sample, environment and health implications.

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2BA.30

The "Oyster of the Air": A New Filtration Bioaerosol Sampler for Environmental Pathogen Surveillance. ARI MACHTINGER, Tim Locksmith, Eli O'Connor, Shelby O'Connor, Dave O'Connor, *University of Wisconsin–Madison*

Bioaerosol sampling in congregate settings such as schools and healthcare facilities allows researchers and public health scientists to perform environmental surveillance of respiratory pathogens. Such air surveillance complements traditional clinical surveillance when performed at scale throughout a community, and gives local insight into pathogen prevalence. However, most bioaerosol samplers cannot be widely scaled throughout a community; samplers that are too loud bother inhabitants of congregate settings, and samplers that are too complicated are not easily used by community partners. Therefore, we developed a novel filtration bioaerosol sampler called the "Oyster of the Air" (OOTA) with the goal of balancing capture sensitivity and the user experience. The OOTA samples at a flow rate of approximately 100 liters per minute with an approximate sound level of 30 decibels. The circular filter is spunbond nonwoven polypropylene with a diameter of 39.5 mm and a density of 34 grams per square meter. Its operation requires minimal user-intervention: a sample consists of just one interchangeable filter holder which fits onto the front of the instrument via a twist lock mechanism, and the instrument is turned on and off by simply plugging and unplugging. The filter is held in place by a rubber band and thus allows for simple removal with forceps. Captured material can be eluted from the filter by soaking in PBS + 0.1% Tween 20 which can be used for nucleic acid isolation and downstream molecular assays such as PCR or sequencing. The casing for the OOTA is 3D printed and its sum parts cost less than $50. The OOTA has been used to sample from an office and a classroom where it has demonstrated comparable detection of RNaseP to the InBio Apollo, and has successfully captured detectable levels of viruses by qPCR including rhinovirus, parainfluenza virus 2, and respiratory syncytial virus.

2BA.31

Droplet Spread on Surfaces. MAHENDER SINGH RAWAT, Chaewoon Jung, Rachael Snodgrass, Alexandra Longest, Vikas Goel, Linsey Marr, *Virginia Tech*

Airborne transmission is one of the primary modes for the spread of respiratory infectious diseases. The role of super-coarse respiratory droplets (larger than ~20 µm) in airborne transmission is not well understood, in part because they are not readily sampled by real-time particle analyzers. Studies have characterized such droplets through deposition on a surface. Of course, droplets spread upon deposition, as a function of liquid properties, surface material properties, and droplet impact dynamics, so a relationship between the size of the suspended droplet and the deposited droplet must be established. The droplets can also shrink due to evaporation, the extent of which depends on the surrounding humidity. The objective of this research is to improve accuracy in characterizing super-coarse droplets by determining the relationship between original droplet size and final deposited size for varying liquid compositions, surface materials, and relative humidity levels.

To investigate how droplet size varies from generation to deposition, we designed an experimental study to characterize the formation and post-generation dynamics of liquid droplets. We used a Droplet-on-Demand (DOD) dispenser, which enables controlled production of droplets with different initial diameters and tested three different relative humidity conditions. Immediately after ejection from the nozzle, the droplets were imaged using a high-speed camera to quantify their initial size. Subsequently, droplets were collected on two different surfaces: (1) Petri dishes with a hydrophobic coating and (2) water-sensitive paper. The deposited droplets were then examined using optical microscopy and image analysis, respectively, to determine their size upon deposition on the surface.

Data collection and analysis are currently in progress. The results of this study will provide experimental insight into droplet transformation upon deposition and will improve methods for characterizing super-coarse respiratory droplets.

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2BA.32

How Aerosol pH Is Affected by Trace Gas Species During an Engineered Inactivation of Pathogenic Aerosols. ZHENYU MA, Hunter Richards, Herek L. Clack, *University of Michigan*

The infectivity of pathogenic aerosols is a critical factor for aerosol transmission of airborne pathogens and diseases. Among the key variables that could cause changes in viral aerosol infectivity, aerosol pH is recognized for its effects on the natural infectivity decay rate of various viral aerosols. (Longest et al., 2024)

However, how aerosol pH can potentially affect the efficiency of an engineered inactivation process has been less examined. It has been found that the effectiveness of disinfection is affected by the liquid substrate pH for viral aerosols deposited on respirators. (Rockey et al., 2020), making it plausible that viral aerosol pH could also affect engineered inactivation methods, such as non-thermal plasma (NTP) exposure, whose virucidal effects, driven by the highly oxidative species produced during the treatment, are well studied.

We have demonstrated that the presence of gaseous ammonia (NH3) and hydrogen sulfide (H2S) can negatively affect the NTP inactivation efficiency of viral aerosols (Ma et al., 2024). This study further investigates the role of trace gaseous air contaminants with aerosol-pH-altering potential, in addition to the effects of NTP treatment on aerosol pH. Results indicate the gaseous effluent of NTP can cause a statistically significant change in the pH of the liquid media used to collect virus-containing aerosols, after accounting for the effects of aeration alone. By comparing the pH of collected aerosols in the presence of different gaseous species with and without NTP exposure, the role of pH-altering gases can be better understood.

2BA.33

Experimental Considerations for Quantifying Airborne Influenza Virus Shedding in the Ferret Model. JOANNA PULIT-PENALOZA, Jessica Belser, Troy Kieran, Nicole Brock, Xiangjie Sun, Hui Zeng, Claudia Pappas, Taronna Maines, *CDC*

Background: The ferret model is widely used to assess the replication, pathogenicity, and transmissibility of emerging influenza A viruses as part of pandemic risk assessment. Quantitative measurement of airborne influenza virus shedding in this model can provide additional insight. However, variability in aerobiology study design may substantially influence the recovery of viral RNA and infectious virus, complicating comparisons across studies and the interpretation of airborne shedding data.

Methods: To evaluate key variables affecting airborne influenza virus detection, we conducted aerosol sampling from A(H1N1)pdm09 influenza A virus-infected ferrets using different air sampling approaches. We assessed the effect of sampling enclosure, particle size fractionation, tubing distance, sampling duration, and sampler platform (BC251, SPOT, and GEM) on recovery of viral RNA and infectious virus. We then applied a standardized sampling approach to collect air from ferrets inoculated with a panel of influenza A viruses representing diverse subtypes to examine relationships among viral replication, airborne virus shedding, and transmission potential.

Results: Sampling conditions strongly influenced detection of airborne virus. Viral RNA recovery was higher when ferrets were sampled in a smaller, more enclosed space than in a larger, perforated cage, consistent with reduced dilution of expelled particles. Shorter tubing distance between the animal and sampler improved detection. Particle size fractionation showed that a substantial proportion of recovered viral RNA was associated with >4 μm larger particle fractions. Comparison of BC251, SPOT, and GEM samplers demonstrated that sampler choice affected RNA detection and infectious virus recovery, with each platform offering distinct advantages. Using a standardized sampling approach, quantitative analysis of nasal wash and air samples revealed a strong correlation between viral loads in the respiratory tract and airborne virus shedding, especially for viruses known to transmit efficiently among ferrets.

Conclusions: These findings demonstrate that methodological variables can substantially affect measurements of airborne influenza virus shedding in animal models. Optimizing and clearly reporting sampling conditions will improve interpretation of in vivo aerobiology studies and facilitate comparison across laboratories. This methodology can aid in identifying zoonotic influenza viruses that may be adapting and evolving toward mammalian transmissibility.

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2BA.34

Design and Performance-Evaluation of a Wet-Cyclone-Based BioAerosol Sampler (WC-BAS) for High-Throughput Collection of Bioaerosols. BOWEN BAI, P. S. Ganesh Subramanian, Andy Kim, Ananya Benegal, Shu-Wen You, Das Bedadeep, Yangjie Tan, Yuezhi (August) Li, Dishit Ghumra, Kumud Mantri, Michael Vahey, Rajan K. Chakrabarty, *Washington University in St. Louis*

Respiratory infections are a leading public health burden globally, and the risk of pathogen transmission through airborne transmission is higher indoors. Most people spend over 90% of their time indoors, making it a critical microenvironment in shaping human health and well-being. High-throughput collection of pathogen-containing bioaerosols and their quantification will facilitate mitigating and reducing the adverse health impacts of airborne transmission of pathogens. Presently, there are several devices that collect bioaerosols into liquid suspensions, which in turn are analyzed to detect and quantify airborne pathogens. However, his approach is time-consuming (for sample collection as well as analysis) and can lead to delays in effectively deploying strategies such as increasing building ventilation, etc., to mitigate airborne transmission.

We designed a high-flow rate (~ 1,000 LPM) Wet-Cyclone-based BioAerosol Sampler (WC-BAS) for collecting bioaerosols. In a controlled chamber environment, we aerosolized PSL spheres of different sizes to quantify the size-resolved collection efficiency of WC-BAS. Subsequently, we aerosolized virus-like particles (VLPs) and collected them using both WC-BAS and the liquid spot sampler (LSS; a research-grade bioaerosol sampling instrument) to evaluate the bioaerosol collection efficiency and throughput of the WC-BAS relative to the LSS.

Size-resolved collection efficiency results of WC-BAS revealed a low cutpoint (d50 = 466 nm). The collection efficiency of VLPs in the WC-BAS was 46±8% as compared to that of the LSS. However, the higher flow rate of the WC-BAS relative to the LSS (1000 vs. 1.5 LPM, respectively) enabled the WC-BAS to collect a 12× higher concentration and 300 × higher throughput of VLPs. Collectively, these results demonstrate the ability of WC-BAS to effectively capture submicron bioaerosols such as viruses at a high-throughput, enabling significantly shorter sampling times to collect detectable concentrations of bioaerosols. We anticipate testing the bioaerosol collection efficiency of inactivated allergens, bacteria, and viruses using the WC-BAS in the future.

2BA.36

A Reusable, Visible-Light-Activated Antimicrobial Pre-Filter for Air Filtration Systems. JAE HAK SHIN, So Yeong Kim, In Ho Kim, Ki Joon Heo, Gi Byoung Hwang, Jae Hee Jung, *Sejong University*

Air filtration is an effective strategy for controlling airborne bioaerosols. However, microorganisms captured on filters may remain viable, increasing the risk of secondary contamination and compromising long-term filter hygiene. Here, we present a reusable, visible-light-activated antimicrobial pre-filter for air filtration systems. A 3D-printed thermoplastic polyurethane (TPU) mesh was functionalized with a gold nanocluster-crystal violet (Au@CV) hybrid and installed upstream of a conventional dust filter. The replaceable pre-filter intercepts coarse particles, thereby reducing dust loading on the main filter, while generating reactive oxygen species (ROS) under visible light. Unlike conventional antimicrobial filters that rely primarily on direct contact, the generated ROS provide both direct antimicrobial activity on the pre-filter and non-contact antimicrobial protection of the downstream filter through airflow-assisted ROS transport.

The Au@CV pre-filter achieved up to a 4.7-log reduction of *Staphylococcus epidermidis* after 3 h of visible-light irradiation. Airflow-assisted ROS transport resulted in >99% antibacterial efficiency on the downstream filter while introducing a negligible pressure drop. Antibacterial performance depended strongly on airflow direction and velocity, highlighting the critical role of airflow in ROS delivery. The functional coating also exhibited excellent mechanical stability and could be readily regenerated through a simple re-dyeing process.

This reusable pre-filter strategy combines coarse-particle interception with visible-light-activated antimicrobial protection, helping to preserve the performance and hygiene of downstream filters while reducing maintenance requirements. The proposed approach offers a practical and energy-efficient strategy for sustainable bioaerosol control in air filtration systems operating under visible-light conditions.

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2BA.37

Comparison of Rutgers Electrostatic Passive Sampler (REPS) and Its Derivatives Across Different Bioaerosol Sampling Environments. NIVEDA THURAVIL, Taewon Han, Gediminas Mainelis, *Rutgers, The State University of New Jersey*

Bioaerosols are airborne particles originating from biological sources, including bacteria, viruses, fungi, and their associated metabolites, such as mycotoxins, endotoxins, and peptidoglycans, which can persist for extended periods in the air. Due to their ability to alter environmental processes and negatively affect numerous living organisms through their toxic, allergic, and infectious properties, it is crucial that they be studied and monitored. However, current active methods used to sample microbes present in the aeromicrobiome require air movers and often have limitations that affect collection time, efficiency, and sample viability. The Rutgers Electrostatic Passive Sampler (REPS), which requires no pumps or power supply, addresses some of these problems and can complement existing active sampling methods. REPS consists of a holder with openings in a spiral configuration that incorporates a polyvinylidene fluoride (PVDF) ferroelectric film woven through to increase surface area. REPS is designed to be left as a stationary sampler at various sampling locations for extended sample collection periods. Over time, derivatives of the REPS were made to adjust to alternate sampling conditions and environments. Personal REPS (P-REPS) was designed to be shorter in height and to be attached to a wearable clip-on holder to collect and measure personal exposure. Weathervane REPS (WV-REPS) was designed as a holder with a rudder to orient the original REPS along the wind direction and collect samples in outdoor environments. This poster presents tests inter-comparing REPS derivatives and settle filters in both outdoor and indoor environments. The collected samples were extracted and analyzed via culture (e.g., CFU counts), microscope counts, ATP activity, and qPCR. Results obtained through this research provide correlations between samplers, extraction methods, and weather conditions, and contribute standardized methods to investigate the aeromicrobiome via passive sampling.

2BA.38

Potential Airborne Microorganism Transfer Into Medication Vials During Syringe-Based Drug Delivery. VIVIAN ACHAO SURGELAS, Taewon Han, Anthony Lenza, Anthony Weiburg, Gediminas Mainelis, *Rutgers, The State University of New Jersey*

During the preparation of injectable medications, air is often drawn into a syringe and introduced into a medication vial to increase internal pressure and aid in medication withdrawal. However, this may present a route for airborne microorganisms to enter the medication vial. This pilot study assessed the feasibility of medication cross-contamination via ambient bioaerosols during syringe draws.

Preliminary chamber experiments were conducted under controlled conditions with aerosolized Staphylococcus epidermidis in a horizontal constant-flow bioaerosol chamber. Bioaerosol was drawn via a sterile 10 mL syringe and transferred (injected) into a vial in phosphate buffer and, along with appropriate blanks, quantified by culture and epifluorescence microscopy. The pilot test study yielded measurable bacterial transfer with an efficiency of approximately 11.3% and a culturability ratio of 66%, and all blanks remained negative. These results suggest a non-zero risk of cross-contamination by syringe transfer.

This study further analyzes how airborne microorganism concentration, air volume, syringe draw speed, receiving liquid type, or contact time influences the transfer and recovery of airborne S. epidermidis. Three different airborne concentrations are compared to determine how they affect bacterial recovery. Total air volume and number of syringe draws are assessed with draws of 10, 100, and 300 mL of air. Syringe pull speed is also evaluated to determine whether it affects bacterial transfer. Lastly, bacterial recovery is assessed between the phosphate buffer and a preservative-containing solution immediately after transfer and again after 24 hours. For each condition, transfer efficiency, culturability, and mean recovery are calculated. Statistical analysis determines whether variables affect recovery.

This work helps determine the probability of medication contamination during syringe-based medication preparation and injection, identifies the factors most likely associated with viable bacterial transfer, and improves safety in syringe medication draws and reduces contamination risk in vials.

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2BA.39

Development of a Pathogen Air Quality (pAQ) Monitor for Real-Time Detection of Airborne Highly Pathogenic Avian Influenza. Dishit Ghumra, P. S. GANESH SUBRAMANIAN, Yuezhi (August) Li, Jash Saravia, Ananya Benegal, Joshin Kumar, Astha Joshi, Kuljeet Seehra, Meng Xu, Michael Vahey, Adrianus Boon, Rajan K. Chakrabarty, *Washington University in St. Louis*

Highly pathogenic avian influenza (HPAI) type A viruses represent a severe threat to domestic and wild bird populations, capable of decimating entire poultry flocks within days. While the 2024 emergence of H5N1 in US dairy cattle underscored the virus's expanding mammalian host range, airborne transmission remains a primary vector of concern in high-density poultry environments. Airborne transmission contributes to rapid outbreaks that cause devastating agricultural and economic losses. Consequently, there is an urgent need to develop and deploy real-time airborne HPAI detection systems within poultry facilities to mitigate transmission risks and strengthen global biosecurity.

We designed a patent-pending electrochemical capacitive biosensor (ECB) for detecting the H5N1 virus. The ECB is modified with a hybrid composite of poly(3,4-ethylenedioxythiophene):polystyrene sulfonate (PEDOT:PSS) and reduced graphene oxide (rGO), and its performance is evaluated. We also designed a high-flow rate Wet Cyclone-based particle-into-liquid Sampler (WCS) for collecting bioaerosols and characterized its particle collection efficiency using polystyrene latex spheres.

The ECB provides rapid (<5 min), highly specific detection of the H5N1 virus, achieving a limit of detection (LoD) of 54 viral RNA copies/mL. To evaluate system robustness under field conditions, virus-laden sample media were spiked with poultry-farm derived swab extracts; the resulting signal deviation remained minimal (< ± 2%), confirming the biosensor's resilience against environmental interferences typical of poultry facilities. Furthermore, the wet cyclone sampler (WCS) operating at a high flow rate of 1000 LPM yields a low cutpoint d_{50} < 500 nm, validating its efficacy in capturing submicron particles and its applicability in capturing viral bioaerosols.

We intend to develop a pathogen Air Quality (pAQ) monitor by integrating the ECB with the WCS and deploying pAQ monitors in poultry farms in the future for in-field validation of airborne HPAI detection.

2BA.40

Multi-Technique Approach for Characterizing Protein Nitration in Aqueous Pollen Protein Extracts. ALEX VOLKOVA, J. Alex Huffman, *University of Denver*

Air pollution produces reactive nitrogen species (RNS) that can nitrate proteins in airborne pollen, potentially changing their structure and biological activity. While previous studies have largely focused on individual purified allergens, less is known about nitration in the context of the whole proteome extract. The objective of this study was to evaluate protein nitration in aqueous pollen protein extracts using a combination of analytical techniques. Proteins extracted from ragweed (Ambrosia artemisiifolia) and Kentucky bluegrass (Poa pratensis) pollen were nitrated with tetranitromethane (TNM). Native and nitrated samples were analyzed using UV-Vis spectroscopy, fluorescence spectroscopy, 3-nitrotyrosine ELISA, RP-HPLC. UV-Vis spectroscopy showed the characteristic absorbance of nitrated tyrosine, while fluorescence intensity decreased following nitration, and ELISA confirmed the formation of 3-nitrotyrosine in BSA equivalent units. HPLC was used to separate the aqueous pollen proteome, and the chromatographic results were used to calculate the nitration degree of certain peaks. These results show that aqueous pollen protein extracts can be successfully nitrated and that multiple analytical methods can be used to detect and characterize these changes.

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2BA.41

Bioaerosol Responses to Tropical Marine Cold Pools, Saharan Dust, and Sargassum. MARINA NIETO-CABALLERO, Kyra Britton, Nick Falk, Tana Gobble, Christine Neumaier, Madison Turner, Sonia Kreidenweis, Susan van den Heever, Sean Freeman, Leah Grant, Russell Perkins, *Colorado State University*

Cold pools — cool, dense air currents generated by evaporating precipitation below cloud base — can redistribute aerosols, including bioaerosols, across the marine surface and boundary layer. Bioaerosols are of particular interest given their ability to serve as ice nucleating particles (INPs) near 0°C and their broader relevance to atmospheric processes and human health. Yet little is known about how bioaerosol abundance and community composition in tropical marine environments respond to distinct atmospheric and oceanic forcings, including cold pools, long-range dust transport, and marine biological sources. During the Relating Atlantic Marine Convection, Ice Nuclei, and Cold pools (RAM-CINC) campaign (June–July 2025), we deployed uncrewed aerial systems (UAS) alongside ship-based instrumentation aboard the R/V Meteor in the tropical eastern Atlantic to sample aerosol and thermodynamic properties across three distinct conditions: cold pool passages (sampled before, during, and after), Saharan dust events, and a sargassum event, when free-floating sargassum seaweed was present at the sea surface. Samples were collected at ship level (bioaerosols), aloft with drone flights (bioaerosols), in the ocean surface microlayer (water), and in rainwater to capture how bioaerosols are distributed across the air-sea interface under these varied conditions. To characterize the microbial communities present, we are applying 16S rRNA and ITS gene sequencing to identify bacterial and fungal taxa across these sample types, complementing concurrent measurements of aerosol concentration, size distribution, ice nucleating activity, and thermodynamic measurements. Here, we present an overview of the RAM-CINC field deployment and sampling design, along with preliminary 16S and ITS sequencing results characterizing bioaerosol communities before, during, and after cold pools, during Saharan dust events, and during the sargassum event. These results offer an initial look at how distinct tropical marine conditions structure bioaerosol populations, with implications for their role in ice nucleation.

2CC.1

Aerosols and Urban Expansion Intensify Storms and Flood Risk in the Texas Triangle. PAOLA CRIPPA, Giacomo Moraglia, Mohamed Aboelnour, *University of Notre Dame*

Rapid urban expansion across the Texas Triangle is poised to alter regional hydro-meteorological hazards, yet the coupled roles of aerosols, convection, and runoff remain insufficiently constrained. This study investigates how projected end-of-century urban growth influences extreme precipitation and flood susceptibility using the Weather Research and Forecasting model with chemistry (WRF-Chem) coupled to a stochastic flood-risk framework. Two high-impact storms, a cold-season frontal system and a prolonged warm-season convective event, are simulated under present-day and future urban-expansion scenarios, with identical meteorological boundary conditions to isolate urban effects.

Results show that urbanization-driven aerosol perturbations, rather than land-surface changes alone, dominate precipitation responses. In the cold-season event, expanded urban emissions enhance activation of accumulation-mode cloud condensation nuclei, increasing latent heat flux and strengthening convective updrafts, leading to statistically significant precipitation increases over San Antonio and Austin. In contrast, the warm-season storm exhibits a heterogeneous response over Dallas–Fort Worth, with early aerosol-driven enhancement of western precipitation followed by reduced buoyancy and suppressed rainfall to the east as storm evolution progresses over the enlarged urban footprint. Coupled hydrological analysis indicates that these precipitation changes translate into a systematic expansion of high-runoff and flood-prone areas. Both WRF-Chem diagnostics and a stochastic SCS-CN framework identify amplification of existing flood-risk hotspots and emergence of new vulnerable zones. Importantly, the simulated aerosol-induced convective invigoration likely represents a conservative lower bound due to unresolved supersaturation at subgrid scales. While limited to two storms, this work demonstrates a scalable, process-based framework linking urban growth, aerosol–cloud interactions, and flood risk. The results highlight increasing hydro-meteorological vulnerability in rapidly urbanizing regions and underscore the need for resilient infrastructure and integrated modeling approaches to assess future extremes under combined urbanization and climate change.

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2CC.2

Extreme Middle Eastern Dust Event over Metropolitan Mumbai, India, Associated with Enhanced Lightning Activity.
ABHIJEET GANGANE, Deen Mani Lal, *Indian Institute of Tropical Meteorology, Pune, India*

This study examines the influence of transboundary dust on lightning activity in the Mumbai region, India, during an extreme pre-monsoon event on May 13, 2024, which resulted in multiple fatalities and injuries. A severe dust intrusion from the Middle East and Arabian deserts coincided with a westward-moving convective system originating from inland Nashik, India, and moving toward the southwestern coast of India. A multi-platform dataset combining ground-based and satellite observations was used. Lightning data obtained from the Indian Lightning Location Network (ILLN), PM_{10} concentrations from the Central Pollution Control Board (CPCB), cloud parameters from satellite and reanalysis, and dust transport pathways from HYSPLIT. Results show that transboundary dust led to an eightfold increase in PM_{10} (~800 µg $m^{-}3$), accompanied by more than 31,000 lightning flashes, with a peak of over 8,717 flashes coinciding with the PM_{10} peak at 16:00 IST. Dust particles altered cloud microphysics by reducing cloud liquid water and enhancing cloud ice water content. This process strengthened deep convection, lowered cloud-top temperatures to ~205K, and elevated cloud tops to ~15-16km. These conditions promote strong non-inductive charge separation, resulting in intense lightning over metropolitan Mumbai. The findings provide robust evidence that long-range transported dust significantly enhances thunderstorm electrification by promoting ice microphysics and increasing lightning activity.

2CC.3

Microphysical and Ice-Nucleating Properties of Aerosols Generated by Modern Cloud-Seeding Materials.
AMIE DOBRACKI, Kaitlyn Suski, Anna Gannet Hallar, Maria Garcia, Ian B. McCubbin, Joseph Bail, Megan Ostlie, Gerardo Carrillo-Cardenas, Naruki Hiranuma, Andre Garcia, Jonathan Jennings, Swarup China, *Rainmaker Technology Corporation*

Cloud seeding has long been used to enhance precipitation in water-limited regions, with glaciogenic seeding of wintertime orographic clouds remaining a primary strategy in the western United States. This study characterizes the microphysical, chemical, and ice-nucleating properties of aerosols generated by modern cloud seeding materials through a series of experiments at Powder Mountain (41.43°N, −111.74°W). Silver iodide (AgI), most commonly dispersed from pyrotechnic flares, is the primary seeding material used due to its structural similarity to ice and effectiveness as a heterogeneous ice-nucleating particle (INP). Despite its widespread use, the ice-nucleating properties of AgI-based materials have primarily been characterized in laboratory studies using older flare formulations and limited particle-resolved instrumentation. Here, sequential releases of AgI-based flares, powdered AgI, ground generators, and aerosolized Snomax and fungal solutions were conducted under consistent meteorological conditions, enabling direct comparison of aerosol properties and INP activity across multiple materials and dispersal methods. Seeding material aerosols were dispersed from an unmanned aerial vehicle (UAV) and sampled through a 10 m turbulent inlet system. Aerosols were analyzed using a suite of online and offline instrumentation to quantify size distributions (Scanning Mobility Particle Sizer, SMPS), temperature-dependent INP concentrations (Portable Ice Nucleation Experiment, PINE), and particle morphology (scanning electron microscopy, SEM). Results show that particle size distributions are controlled by seeding material and dispersal methods, spanning modes from ~40 nm (ground generators and biological aerosols) to ~100 nm (flares) and 3–5 µm (powdered AgI). Initial PINE measurements indicate variability in ice-nucleating activity (INA) across materials and dispersal methods, consistent with differences in particle size and morphology observed in SEM analysis. These findings provide new constraints on how aerosol generation pathways influence INP populations and offer insight into optimizing cloud seeding strategies.

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2CC.5

Photochemical Cloud Processing of Water-Soluble Organic Gases Produced by Aqueous-Phase Photooxidation of α-Pinene, d-Limonene and Toluene. MATT ZARAGOZA, Lisa Wingen, Sergey Nizkorodov, Annmarie Carlton, *University of California, Irvine*

Ambient water-soluble organic gases (WSOGs) are photochemically processed in atmospheric waters, which contributes to aqueous secondary organic aerosol (aqSOA). Chemical characterization of this atmospheric pathway has not previously been undertaken for monoterpene or aromatic oxidation products. In this work, gas-phase α-pinene, d-limonene, and toluene were oxidized via •OH-initiated reactions. Resulting gas-phase WSOGs were isolated from particles and partitioned into the aqueous-phase by aqueous droplets inside a mist chamber. WSOG samples were then subjected to aqueous-phase photooxidation to quantify aqSOA mass yields and characterize aqSOA chemical composition. AqSOA particle mass concentrations increased with aqueous-phase photooxidation time for monoterpene WSOGs, driven by the production of lower volatility monomeric species. Only marginal increases were observed for toluene WSOGs. Both WSOGs and resulting aqSOA exhibited higher O/C ratios than SOA formed during gas-phase reactions, primarily due to the presence and formation of small functionalized organic acids. Mass spectra for α-pinene WSOGs showed an abundance of small carboxylic acids (C1 - C4) and monomeric (C7 - C10) carbonyls formed during the aqueous-phase photooxidation. The α-pinene WSOGs exhibited a distinct molecular composition and underwent different photochemical processes when contrasted with water-soluble organic particles (WSOPs) from the gas-phase •OH-initiated oxidation of α-pinene. WSOPs were determined to contain dimeric compounds, which underwent fragmentation during aqueous photooxidation, while WSOGs did not contain dimers. The photochemical aqueous processing of WSOGs represents the fate of 1.4%, 1.2%, and 0.28% of α-pinene, d-limonene, and toluene, respectively, which is an order of magnitude lower than mass yields from SOA produced during gas-phase reactions. This photochemical aqueous processing pathway for α-pinene, d-limonene, and toluene could therefore represent 0.9%, 0.1%, and 0.02% of the global total SOA production rate, respectively. These results underscore the need for chemical-level characterization of monoterpene derived WSOGs to quantitatively evaluate their potential contribution to the global atmospheric aqSOA burden.

2CC.7

The U.S. DOE Atmospheric Radiation Measurement (ARM) User Facility: Observational Infrastructure for Advancing Aerosol and Atmospheric Process Research. ADAM THEISEN, Olga Mayol-Bracero, Janek Uin, Scott Smith, Arthur J. Sedlacek, Ashish Singh, Maria A. Zawadowicz, Ogochukwu Enekwizu, Jessie Creamean, Sarah Petters, Markus Petters, Fan Mei, Peng Wu, John Shilling, Nicki Hickmon, *Argonne National Laboratory*

The U.S. Department of Energy Atmospheric Radiation Measurement user facility (ARM) provides long-term, continuous observations of atmospheric processes across a range of environments. ARM operates a globally distributed network of fixed, mobile, and aerial facilities and platforms, enabling high-resolution aerosol measurements in a variety of regimes. ARM deploys a comprehensive suite of integrated surface-based, airborne, and remote sensing aerosol measurements. In situ measurements from Aerosol Observing Systems and aircraft-based instrumentation provide detailed information on aerosol size distributions, chemical composition, hygroscopicity, and optical properties, with remote sensing systems extending these observations vertically to capture aerosol structure and evolution. Together, these coordinated observations provide a multi-scale view of aerosol variability and evolution.

All ARM data are openly available and supported by a robust infrastructure that includes standardized data streams, value-added products, and open-source analysis tools. This framework enables users to perform process-level studies, evaluate models, and develop new analysis approaches, including emerging artificial intelligence applications.

Through coordinated field campaigns, sustained observations, and ongoing enhancements to instrumentation and data systems, ARM continues to support scientific advancement of atmospheric process understanding. This presentation will provide an overview of ARM's measurement capabilities, data resources, and opportunities for engagement, with emphasis on how ARM observations can be leveraged to advance aerosol research.

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2CC.8

Tracking Water Vapor Homogeneous Nucleation and Droplet Growth with Spectroscopy and Holography in a Free Expansion Cloud Chamber. COLE SAGAN, Gwenore Pokrifka, Samuel M. Koblensky, Martin Erinin, Ilian Ahmed, Nadir Jeevanjee, Luc Deike, Marissa Weichman, *Princeton University*

We use a newly commissioned rapid expansion aerosol chamber (REACh) facility to study the homogeneous nucleation of water vapor to form liquid droplets. We perform high-speed measurements to track the partitioning of water into vapor and droplets throughout the expansion process, including tunable diode laser absorption spectroscopy (TDLAS) to access the vapor concentration and in-line holography to track the size and concentration of nucleated droplets. We retrieve the peak saturation ratio achieved in each expansion from the TDLAS measurements in combination with adjusted thermocouple temperature readout. We monitor the number of nucleated droplets and their subsequent growth as a function of saturation ratio and observe the onset of homogeneous nucleation of water vapor occurring at a threshold saturation ratio near S=5, in agreement with prior literature and classical nucleation theory. The trends we observe in average diameter and droplet concentration suggest that warm air pockets near the chamber walls inhomogeneously mix with cold air at the center of the chamber following expansion. Active forced mixing of the chamber with fans yields more homogeneous temperature readings, but also significantly broadens the droplet size distribution due to the smaller scale fluctuations from mixing. Our results demonstrate the capability of TDLAS and holography techniques to track both water vapor and liquid water in the high saturation ratio environments necessary for the homogeneous nucleation of droplets. Our findings also reveal that droplet nucleation and growth dynamics are highly sensitive to turbulence. In ongoing work, we are applying similar techniques in the presence of seeding CaCO3 nanoparticles to study the impact of mixing on heterogeneous nucleation and droplet growth. Finally, we are working to cool the REACh chamber walls to study ice crystal nucleation and growth under stratospheric and upper-tropospheric conditions.

2CC.9

Interpretable Machine Learning of Aerosol Physicochemical and Environmental Controls on Cloud Condensation Nuclei. WEIXING HAO, Manisha Mehra, Ruoyu Zhang, Fan Mei, Yang Wang, *University of Miami*

Cloud condensation nuclei (CCN) play an important role in aerosol–cloud interactions and climate, yet their variability is governed by complex interactions among aerosol size distribution, physicochemical properties, and environmental conditions. This study develops an interpretable machine learning framework to identify the aerosol physicochemical and environmental factors controlling CCN variability across contrasting atmospheric environments. We analyze size-resolved aerosol observations, hygroscopicity and chemical composition measurements, and meteorological conditions across contrasting atmospheric environments at the Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) Southern Great Plains, Eastern North Atlantic, and North Slope of Alaska sites. Tree-based machine learning models are used to predict CCN concentrations and quantify the relative importance of particle size, hygroscopicity, chemical composition, and environmental factors. Current CCN-focused evaluations using SMPS size-distribution features show strong predictive performance, with representative R^2 values of 0.86. Feature-importance analysis indicates that CCN prediction is dominated by particles in the upper Aitken to lower accumulation-mode range, approximately 70–150 nm. Supersaturation-dependent analysis further shows that influential particle sizes shift toward smaller diameters at higher supersaturation, consistent with the expected decrease in critical activation diameter from Köhler theory. Building on these results, the extended framework incorporates aerosol hygroscopicity, chemical composition, and meteorological variables to evaluate their contributions to CCN variability and determine how the relative importance of these controls changes with supersaturation and atmospheric conditions. Overall, this framework provides a scalable and physically interpretable approach for understanding the physicochemical and environmental controls on CCN across diverse atmospheric environments.

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2CC.10

Diurnal Observations Demonstrate Nighttime Abundance of Heat-Liable Biogenic Ice-Nucleating Particles in Bankhead National Forest. KATIE CHAN, Jing Li, Darielle Dexheimer, Casey Longbottom, Pranav Dawar, Sarah Williams, Nurun Nahar Lata, Swarup China, *University of California Los Angeles*

Approximately one in a million aerosols act as ice-nucleating particles (INPs), initiating primary ice formation in mixed-phase clouds, thereby influencing cloud radiative properties and precipitation processes. Bioaerosols (e.g., pollen, bacteria, and plant debris) and bio-organic particles derived from them can act as efficient warm-temperature INPs (active above -15 °C), yet their contributions remain underrepresented in models due to limited observational constraints. In this study, we characterize INPs using ground-based ambient aerosol samples collected in 12-hour daytime and nighttime periods over eight days in August 2025 at the U.S. Department of Energy's Atmospheric Radiation Measurement (ARM) site in Bankhead National Forest in northwestern Alabama. Samples are analyzed using the Nucleation of Ice integrated with nanoPOTS Apparatus (NIPA), an automated droplet freezing assay system for high-precision immersion-mode freezing experiments, with a subset heat-treated to remove heat-liable proteinaceous INPs. Results show that nighttime total INP number concentrations were consistently higher than daytime values, along with a stronger contribution from heat-liable proteinaceous INPs at night, with median freezing temperatures shifted ~2.5 °C warmer relative to the total INP population. This likely reflects enhanced accumulation of biogenic material under low wind speeds, and its release under high relative humidity and precipitation events. Air mass back-trajectory analysis indicates that INPs measured at the ground level at Bankhead National Forest were primarily influenced by local biogenic emissions, with minimal contribution from long-range transported vegetation-derived aerosol sources. These findings improve our understanding of biogenic emissions as contributors to the INP population in Bankhead National Forest, where frequent convective storms bring regular precipitation to the area, while providing observational constraints to improve INP parameterizations in coupled land-atmosphere models.

2CC.11

Quantitative Estimates of Upwind and Onsite Particle Scavenging and Retrieved Cloud Supersaturations from Urban Coastal Stratocumulus During EPCAPE. JERAMY DEDRICK, Atsushi Osawa, Lynn M. Russell, Mark Miller, Lauren T. Robinson, Rachel Chang, Abigail Williams, Veronica Berta, Elavarasi Ravichandran, Markus Petters, Michael Wheeler, Sanghee Han, Christian Pelayo, Nattamon (Jeep) Maneenoi, Dan Lubin, Janek Uin, Ogochukwu Enekwizu, Maria A. Zawadowicz, Olga Mayol-Bracero, Cynthia Twohy, *Teledyne API*

Cloud processing modifies aerosol number size distributions, imprinting a Hoppel minimum set by the effective supersaturation and by the scavenging of interstitial particles and gases. Using one year of aerosol and cloud observations from the DOE ARM Eastern Pacific Cloud Aerosol Precipitation Experiment (EPCAPE), coastal aerosol size distributions were classified using k-means clustering into three categories: "Broad Accumulation" (38-39%), "Bimodal" (34-37%), and "Broad Aitken" (25-27%). Broad Accumulation and Broad Aitken distributions were associated with recent regional emissions, whereas Bimodal distributions exhibited Hoppel minima indicative of recent and repeated cloud cycling. For Bimodal distributions, each 10% increase in upwind cloud vertical fraction corresponded to a negligible change in Hoppel minimum diameter but a 49±13 cm-3 reduction of the Aitken-mode number concentration and 2±1 nm increase in accumulation-mode diameter. Cloud events sampled at Mt. Soledad showed negative correlations between post-cloud Aitken-mode number concentration and Hoppel minimum diameter, consistent with enhanced scavenging during longer-lived clouds with higher droplet number concentrations and greater coagulation efficiency. Supersaturation retrievals based on cloud-scene and parcel methods were 0.03-0.13%, showing sufficient local resolution to quantify variability with cloud base updraft velocity, whereas Hoppel-minimum-based estimates were higher at 0.2-0.3%, reflecting maxima over ensembles of recent cloud cycles. Retrieved supersaturations were positively correlated with liquid water content and droplet number concentration, indicating increased CCN activation at higher supersaturation. These results demonstrate that aerosol size distributions and CCN measurements constrain both cloud scavenging and effective cloud supersaturation, furthering our understanding of aerosol perturbations to coastal marine boundary layer clouds.

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2CC.12

Characterization of Black Carbon Aerosols off the Coast of Southern California During the SCILLA Campaign. Dongli Wang, Minghao Han, Bradley Ries, Roya Bahreini, Mikael Witte, Patrick Chuang, Anthony Bucholtz, Don Collins, ANDREW METCALF, *Clemson University*

Black carbon (BC) aerosols have significant impacts on climate through direct atmospheric absorption, semidirect effects on cloud structure, and indirect effects on cloud microphysics and yet remain largely uncertain in the magnitude of these effects. To address this uncertainty, comprehensive airborne observations were conducted off the coast of Southern California in June 2023 as part of the Southern California Interactions of Low Cloud and Land Aerosol (SCILLA) campaign. Several sampling strategies examine BC transport, vertical evolution, and cloud activation in the Southern California Bight, including datasets which contrast stratocumulus-topped and cloud-free conditions across the San Diego to the Los Angeles outflow region. Measurements from above-, below-, and in-cloud regions are used to assess BC incorporation into cloud droplets and meteorological influences.

A general gradient of higher aerosol concentrations near the coast to cleaner conditions offshore reflects the influence of urban outflow from nearby coastal cities to the marine environment. In the Bight region, cloud droplet sizes decreased from upwind of San Clemente Island to downwind regions. Below-cloud aerosol number concentrations were generally higher in the downwind region than in the upwind region for each flight, likely reflecting island-wake dynamics that modified boundary-layer flow and mixing. BC-containing particles were mainly observed in the 180-210 nm size range, and size-dependent ratios of BC residuals to out-of-cloud BC indicates preferential enrichment of larger BC-containing particles within cloud residuals. Higher ratios of BC residuals to below-cloud BC than to above-cloud BC suggest that cloud-droplet BC more closely reflects below-cloud BC, consistent with activation near cloud base. The vertical evolution of BC indicates efficient aerosol exchanges, including cloud processing and activation. Overall, this detailed characterization provides insight into the connection between BC aerosol, cloud microphysical properties, and local meteorology, and helps evaluate the role of BC-containing particles in the marine boundary-layer environment.

2CC.13

Selective Enrichment of Mineral Dust and Biogenic Particles in Ice-Nucleating Particles from Soil-Derived Particles Under Mixed-Phase Cloud Conditions. NURUN NAHAR LATA, Gourihar Kulkarni, Alla Zelenyuk, Gregory W. Vandergrift, Ashfiqur Rahman, Ava Sealy, Naruki Hiranuma, Swarup China, *Pacific Northwest National Laboratory*

Soil-derived particles are important sources of ice-nucleating particles (INPs), yet the particle- and soil-level factors that control their activation under mixed-phase cloud conditions remain poorly constrained. In this study, we investigated aerosolized surface soils collected from four U.S. sites within the Molecular Observation Network (MONet), spanning differences in soil texture, land cover, elemental composition, carbon and nitrogen content, pH, cation exchange capacity, and microbial activity. Ice nucleation activity was quantified using continuous flow diffusion chamber measurements for size-selected 500 and 700 nm particles, complemented by droplet freezing assays to assess temperature-dependent INP activity from approximately −5 to −25 °C. To determine which particles preferentially activated as ice, ice crystal residuals were isolated using a pumped counterflow virtual impactor and compared with the total particle population using computer-controlled scanning electron microscopy with energy-dispersive X-ray spectroscopy and miniSPLAT single-particle mass spectrometry. The activated ice residuals were compositionally distinct from the total aerosol population, demonstrating selective enrichment of specific particle types during ice nucleation. Mineral dust, carbonaceous-mineral mixtures, and biogenic particle types were preferentially represented among ice residuals, indicating that only a subset of the soil aerosol population contributes efficiently to ice formation. CFDC measurements further revealed size-dependent ice activation, with differences between 500 and 700 nm particles suggesting that particle size, surface area, and composition jointly regulate INP efficiency. Across the soil samples, bulk soil properties were strongly linked to temperature-dependent ice nucleation behavior, with organic-rich and biologically influenced soils showing enhanced activity at warmer temperatures, while mineral-associated particles became increasingly important at colder temperatures. These results demonstrate that soil INP activity cannot be described by aerosol abundance alone, but instead reflects the coupled influence of soil biogeochemistry, particle size, and single-particle composition. This work provides observational constraints needed to improve composition-resolved representations of soil-derived INPs in mixed-phase cloud models.

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2CC.14

Aerosol Microphysics Model Intercomparison and Machine Learning Emulation for Stratospheric Aerosol Injection. ALI AKHERATI, Duncan Watson-Parris, Jeffrey R. Pierce, Daniele Visioni, Marianna Linz, *Reflective Org.*

Stratospheric aerosol injection (SAI) remains one of the most studied solar geoengineering approaches, yet significant uncertainties persist in projecting its climate impacts. A major source of these uncertainties stems from the evolution of aerosol microphysics, which governs particle size distribution, composition, and radiative properties. Currently, multiple aerosol microphysics models exist, each employing different methodologies and underlying assumptions that lead to divergent predictions under SAI conditions.

This work will present a systematic intercomparison of leading aerosol microphysics models to quantify how their structural differences affect simulated aerosol evolution in SAI scenarios. We will explicitly test the differences in key assumptions and process representations across models, including nucleation schemes, coagulation kernels, and condensational growth parameterizations. By isolating these individual processes, we will identify which components contribute most significantly to inter-model spread and elucidate the mechanistic drivers of divergent predictions under various SAI conditions.

To address the computational limitations that prevent incorporating detailed microphysics in fully coupled climate models, we will develop a machine learning emulator trained on the ensemble of microphysics model outputs. This emulator will accurately reproduce the behavior of computationally expensive microphysics schemes while achieving orders-of-magnitude speedup, enabling more comprehensive representation of aerosol processes in long-term climate simulations. Our approach will provide a path forward for reducing uncertainty in SAI assessments while maintaining computational feasibility.

2CC.16

Carbonyl-Dependent Deliquescence in Brown Carbon Films Measured by Quartz Crystal Microbalance. Kyra Harada Alcantara, Alex Hobrath, Stephanie Gonzalez, PAULA K. HUDSON, *California State University, Fullerton*

Brown carbon (BrC) aerosol particles can influence climate directly by absorbing radiation and indirectly by altering cloud formation through hygroscopic growth and phase state. Yet, the water uptake and phase transitions of BrC formed from small carbonyl–amine reactions remain uncertain. Here, we examine hygroscopic water uptake and deliquescence behavior of BrC produced from glyoxal (GX) or methylglyoxal (MeGX) reacted with methylamine (MeAM) across a range of precursor molar ratios, representing varying degrees of reactivity and precursor availability. BrC reaction products were generated in solution, deposited onto a quartz crystal microbalance (QCM) sensor, and housed in a flow cell. After deposition, films were conditioned in dry air for 24 h prior to exposure to increases in relative humidity (RH) while continuously monitoring QCM oscillation frequency. Frequency decreases were interpreted as net water uptake by the condensed-phase, where frequency increases indicate a solid-to-aqueous phase (deliquescence) transition. To mimic atmospheric cloud processing, samples were cycled between humidified and dry air. GX and GX:MeAM products show increasing deliquescence relative humidity (DRH) values with increasing GX mol fraction in the reaction mixture. Notably, pure GX deliquesced at lower RH (66%) than GX:MeAM mixtures spanning 1:4, 1:2, 1:1, and 2:1 GX:MeAM (70–83% RH) ratios, suggesting that incorporation of amine-derived products can suppress deliquescence. Additionally, GX:MeAM mixtures show film loss during the wet phase of the RH cycling, likely due to evaporation of GX. Although the DRH of MeGX and MeGX:MeAM products exceed our maximum experimental RH and are reported as greater than 80% RH, MeGX:MeAM mixtures show greater water uptake prior to deliquescence than GX:MeAM mixtures. These results demonstrate that BrC hygroscopicity and phase behavior depend strongly on carbonyl identity and mixing ratio, with implications for BrC cloud cycling, lifetime, and climate impacts.

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2CC.17

Impact of Organosulfates Formation on Aerosol Hygroscopicity and Its Implications for Cloud Condensation Nuclei Activity in a Subtropical Forest. XIANGXINYUE MENG, Ajith Thenoor Chandran, Kyle P. McCary, Alan R. Gonzalez, Heewon Yim, Yuzhou Wang, Qi Ying, Maria A. Zawadowicz, Yue Zhang, *Texas A&M University*

Interactions between biogenic precursors and anthropogenic pollutants shape the aerosol composition of the southeastern United States, driving substantial formation of organosulfates (OSs) through conversion from inorganic sulfates. However, the climate impacts of OSs remain poorly constrained. This study utilizes a year-long (Nov 2024-Nov 2025) dataset of the time-of-flight aerosol chemical speciation monitor and cloud condensation nuclei (CCN) observations at the Bankhead National Forest (BNF) atmospheric observatory to examine the role of OS in modulating aerosol properties. A distinct summertime non-refractory submicron aerosols maximum concentration was observed, mostly comprised of organic and sulfate. Positive Matrix Factorization analysis revealed enhanced secondary organic aerosols derived from isoprene epoxydiols (IEPOX-SOA) during summer and fall, indicating robust photochemical processing and heterogeneous formation pathways in the BNF site. By employing a fragment-based mass spectral deconvolution, this study successfully apportioned the total sulfate signal to quantify OSs, methanesulfonic acid, and inorganic ammonium sulfate separately. Results show a persistent OS predominance throughout summer and early fall, aligning closely with the IEPOX-SOA/sulfate ratio. Further analysis demonstrated that traditional "total sulfate" derived aerosol mass spectral data leads to a significant overestimation of the hygroscopicity parameter (κ) of aerosol particles, if reclassifying OSs was not considered. The overestimation peaks during the summer-to-fall transition, leading to a 2-fold overestimation of κ. The CCN closure analysis further confirms that accounting for OS-specific hygroscopicity significantly improves CCN predictability. These findings underscore the importance of considering OS when accurately assessing the hygroscopicity of aerosols and representing the regional radiative budget in areas with strong biogenic emissions, showing that including the OS fraction can significantly reduce the bias of aerosol-cloud interactions in current earth system models.

2CC.18

Cold-Stage System for Impact-Initiated Contact Freezing Experiments (C-ICE): Quantifying Contact Freezing of Ice-Nucleating Particles. JINGCHUAN CHEN, Upasna B. Rai, Kyle McMillan, Ryan Davis, Margaret Tolbert, Sarah D. Brooks, *Texas A&M University*

Ice nucleation by atmospheric aerosols plays a central role in cloud microphysical processes, exerting strong influences on Earth's radiation balance and precipitation formation. Among heterogeneous ice nucleation pathways, contact freezing induced by aerosol-droplet collisions remains one of the least quantitatively constrained, largely due to the scarcity of experimental approaches capable of directly probing impact-initiated freezing under controlled and reproducible conditions. Here we present the Cold-stage system for Impact-initiated Contact freezing Experiments (C-ICE), a laboratory system developed to enable controlled, repeatable, and size-resolved investigation of contact freezing triggered by particle-droplet collisions. C-ICE combines a fixed supercooled droplet with a precisely conditioned aerosol jet, allowing particle size, number concentration, collision geometry, and thermodynamic state to be independently characterized and experimentally constrained. Freezing onset is defined as the temperature at which ice nucleation is first initiated following particle-droplet collision. At the single-droplet level, onset is identified using complementary optical criteria based on breath figure formation and grayscale analysis. Application of C-ICE to silver iodide (AgI) aerosols reveals sharp frozen fraction transitions over narrow temperature intervals (≈2 ℃), with median freezing temperatures shifting systematically toward higher values from -12.7 ℃ for 200 nm particles to -12.1 ℃ for 800 nm particles, and to -10.2 ℃ for polydisperse particles. By integrating a theoretical collision model with experimentally determined collision efficiencies, we constrain the collision efficiency of the C-ICE system, enabling measured aerosol concentrations to be converted into effective particle fluxes impinging on the droplet. We further report the contact freezing properties of a series of mineral dust and soil samples. C-ICE provides a quantitative approach for investigating impact-initiated contact freezing and advances process-level understanding of contact freezing in clouds. The system further provides a physically grounded basis for improving contact freezing parameterizations in atmospheric models and for reducing uncertainties in cloud ice simulations.

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2CC.19

Cloud-Adjacent Vertical and Horizontal Heterogeneity of Aerosol Composition over Southeastern US Forest. SIJIA LIU, Gregory W. Vandergrift, Zezhen Cheng, Nurun Nahar Lata, Ashfiqur Rahman, Zhenli Lai, Xena Mansoura, Beat Schmid, Matthew A. Marcus, Alla Zelenyuk, Celia Faiola, Sergey Nizkorodov, Fan Mei, Damao Zhang, Swarup China, *Pacific Northwest National Laboratory*

Above forested regions, aerosol composition reflects a combination of biogenic precursor emissions, oxidation chemistry, and cloud processing, yet how these properties evolve vertically and horizontally near clouds remains poorly characterized, in part because the small particle masses collected aloft fall below the detection limits of most offline techniques and demand highly sensitive analytical methods. To address this gap, we deployed the ArcticShark uncrewed aircraft system (UAS) over the Atmospheric Radiation Measurement (ARM) site, Bankhead National Forest (Alabama, USA), on 4-7 August 2024 to collect coupled molecular- and particle-level measurements across a range of altitudes and horizontal transects. The microgram-scale samples were analyzed by nanospray desorption electrospray ionization high-resolution mass spectrometry (nano-DESI-HRMS) for molecular composition, together with scanning transmission X-ray microscopy (STXM) and computer-controlled scanning electron microscopy (CCSEM) for single-particle morphology, mixing state, and elemental analysis. Within the boundary layer, vertical gradients dominated over horizontal variability at the scale sampled. Organosulfate abundance increased with altitude, peaked just below cloud base, and dropped above cloud top. IEPOX-derived species, particularly 2-methyltetrol sulfate, dominated the organosulfate signal, pointing to enhanced IEPOX multiphase chemistry and convective transport near cloud base. Horizontally collected samples showed broadly similar molecular composition, indicating that vertical gradients and cloud-aerosol interactions outweighed horizontal heterogeneity at the scales sampled. Together, these results resolve the near cloud aerosol compositional variability and underscore the importance of vertically resolved, high-sensitivity sampling for constraining biogenic aerosol evolution and aerosol-cloud interactions.

2CC.21

Human-Disagreement-Aware Machine Learning for New Particle Formation Event Classification from Size-Time Matrices. RUOYU ZHANG, Yang Wang, Wenyu Chu, Manisha Mehra, Weixing Hao, *University of Miami*

New particle formation (NPF) event classification from long-term particle size distribution measurements is central to aerosol observational studies, but remains labor-intensive and partly subjective, especially for weak, undefined, or transitional events. Conventional automated approaches often rely on hard labels and hand-engineered summary features, which may obscure both the structure of the original size–time matrix and disagreement among human annotators.

Here, we develop a human-disagreement-aware machine learning framework for NPF event classification using 5,693 measurement days. Soft-label targets are constructed from vote distributions across five annotators, allowing the model to learn from both consensus and ambiguity rather than forcing each day into a single deterministic class. We compare two complementary approaches: a feature-engineered gradient boosting machine baseline and raw-matrix deep learning models trained directly on daily size–time tensors.

Preliminary results show that raw-matrix learning is feasible. A compact convolutional model trained on a small development split approached the estimated human agreement ceiling, with errors concentrated in the same ambiguous classes where annotators disagree most strongly. Performance was strongly stratified by human agreement: reaching about 80% accuracy for majority-consensus cases and up to 97% agreement under the strictest consensus/plausibility criterion. In contrast, performance decreased on contested days, particularly for undefined and Class II events, consistent with the low inter-annotator agreement for these categories.

These findings suggest that NPF event classification is not simply an automated labeling problem, but an uncertainty-aware learning problem over physically structured size–time data. The final study reports full five-class cascade results under leave-one-station-out validation, including per-class F1, balanced accuracy, agreement-stratified performance, and comparison to the feature-engineered GBM baseline.

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2CC.22

Impact of Future Climate Conditions on Aerosol Formation. CHRISTIAN MARK SALVADOR, Meng-Dawn Cheng, Jonathan Stelling, Kyle Pearson, Mark Guilliams, Paul Hanson, *Oak Ridge National Laboratory*

Extreme future climate conditions are projected to cause unprecedented deviations in the formation of aerosols, which in turn will cause feedback mechanisms that will affect atmospheric warming, agriculture, sea surface temperature, and more. Each process during the new particle formation, from the emission of volatile organic compounds (VOCs) to condensation of small particles, is influenced by temperature and CO2 mixing ratios that will be enhanced significantly in the future because of extensive burning of fossil fuel. Although studies have been done regarding the effect of temperature and CO2, direct observational evidence under real environmental conditions regarding the response of NPF to extreme climate conditions (i.e., 900 ppm CO2, approximately +4.5°C–9.0°C above ambient) is still limited. Such a knowledge gap poses large uncertainty in the projection of global Earth system models that assess the aerosol–cloud–climate interaction. This study evaluated particle size and distribution during aerosol formation events, as well as event's frequency and growth rate under futuristic climate conditions in a boreal forest—a region projected to be more climate-sensitive (i.e., warm at a faster rate). This study was accomplished in the Spruce and Peatland Responses Under Changing Environments (SPRUCE) site at ORNL, which houses modified open-top chambers with precise whole-ecosystem warming (below- and aboveground) and has elevated CO2 addition capabilities. Concurrent measurements of real-time particle counts and sizes were implemented by deploying a NanoScan SMPS Nanoparticle Sizer 3910 at corrals with ambient and elevated temperature conditions, as well as enhanced CO2 concentration. Moreover, the synergistic effect of elevated CO2 (900 ppm) and temperature (+9°C) on the variability of aerosol formation was analyzed. Two field campaigns were implemented in the summer of 2023 (July 3–August 22, 2023) and spring of 2024 (April 4–30, 2024). In addition to particle size and number information, the concentration of inorganic gases was monitored using a 2B Tech Model 202 Ozone Monitor and QUANT-AQ MODULAIR that provided the real-time concentration of atmospheric aerosols with different particle sizes and four gas-phase pollutants (including CO, NO2, and O3). All the instruments were housed in a 24 × 24 × 24 in. painted steel enclosure with a heated plate and fan module. Detailed results will be discussed in the poster presentation.

2CC.25

Development of a Machine Learning Surrogate to Improve Predictions of Aerosol-Cloud Interactions. ORIOLE SONG, Regina Luu, Kieudiem Nguyen, ManishKumar Shrivastava, Manabu Shiraiwa, Celia Faiola, *University of California, Irvine*

Sub-grid aerosol processes affect cloud condensation nuclei activity, droplet activation, and precipitation initiation, yet remain too computationally expensive to resolve explicitly in regional and global models. Aerosol-cloud interactions are particularly sensitive to non-linear links among particle size distributions, updraft velocity, and cloud droplet formation. We present the development of a machine learning surrogate designed to emulate the Kinetic Multi-layer Model of Gas-Particle Interactions (KM-GAP) coupled with the 2-D Volatility Basis Set with peroxy radical chemistry (r2D-VBS) to address this challenge. The surrogate is trained to map a variety of inputs, including particle size distributions, gas- and condensed-phase mass across volatility bins, temperature, and relative humidity. The surrogate predicts net mass flux in each particle size bin, glass transition temperature, and aerosol viscosity, which is used by the particle- and turbulence-resolved Explicit Mixing Parcel Model with Chemistry (EMPM-Chem) to simulate aerosol-cloud interactions at timesteps <1 minute. Results will be evaluated against DOE ARM Bankhead National Forest observations. This work establishes a method for embedding explicit aerosol kinetics into turbulence-resolved simulations at a reasonable computational cost, laying the foundation for future integration into larger models such as WRF-Chem and E3SM to improve precipitation prediction.

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2CC.26

Evaluating Aerosol Classification and Radiative Forcing Effects Using Ground-Based AERONET Observations. SWAGATA MUKHOPADHYAY, Shantikumar Singh Ningombam, *Indian Institute of Astrophysics, Bengaluru*

Atmospheric aerosols influence Earth's climate by scattering and absorbing incoming solar radiation (direct effects) and altering cloud properties (indirect effects), thereby affecting the Earth's radiation balance, atmospheric heating, cloud formation, and regional to global climate patterns. Their high temporal and spatial variability, together with differences in chemical composition, size distribution, and optical characteristics, make accurate estimation of aerosol radiative forcing (ARF) one of the greatest challenges in climate research. To address this issue, this study presents a comprehensive global assessment of aerosols using observations from 171 Aerosol Robotic NETwork (AERONET) sites distributed across six continents. Based on aerosol optical and absorption properties, aerosols were classified into seven types: Pure Dust (PD), Pollution-Dominated Dust (PDM), Dust-Dominated Mixture (DDM), Strongly Absorbing (SA), Moderately Absorbing (MA), Weakly Absorbing (WA), and Very Weakly Absorbing (VWA). Ground-based observations were complemented by Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) measurements to characterize aerosol vertical distribution and optical properties. The Santa Barbara DISORT Atmospheric Radiative Transfer (SBDART) model was employed to estimate ARF for each aerosol type. Results show that North Africa is dominated by PD aerosols, while Asia is characterized by DDM and mixed dust-pollution aerosols due to its diverse topography, climatic conditions, and extensive land cover. Europe and North America are primarily influenced by anthropogenic aerosols represented by the VWA, WA, and MA types. In contrast, SA aerosols dominate South America, Southeast Asia, and southern Africa, where biomass burning and forest fires are the major sources. SA aerosols produce the highest atmospheric radiative forcing (30.14 ± 8.04 W m^{-2}) and heating rate (0.85 K day^{-1}), whereas VWA aerosols exhibit the lowest atmospheric radiative forcing (7.83 ± 4.12 W m^{-2}) and heating rate (0.22 K day^{-1}), highlighting the strong dependence of aerosol radiative effects on aerosol type.

2CC.27

Organic Aerosol Composition and Particle Size Distributions Influence Composition-Based Aerosol Hygroscopicity Estimates. VERONICA BERTA, Lynn M. Russell, Jeramy Dedrick, Christian Pelayo, Abigail Williams, Sanghee Han, Atsushi Osawa, Ryan Farley, Allison Aiken, Elavarasi Ravichandran, Markus Petters, *Scripps/University of California San Diego*

Cloud condensation nuclei (CCN) activity, the ability of aerosols to activate into cloud droplets, is governed by particle composition and size, yet the influence of organic aerosol oxidation state and particle size on hygroscopicity remains poorly constrained in coastal environments where marine and urban air masses mix. During the Eastern Pacific Cloud Aerosol Precipitation Experiment (EPCAPE), CCN activity at 0.2–1.0% supersaturation (S_c) was measured alongside aerosol composition at Mt. Soledad in coastal La Jolla, California. Multiple linear regression (MLR) was used to evaluate the influence of aerosol composition and elemental ratios on hygroscopicity (κ). Early results have shown that incorporating elemental ratios (O/C, S/C, and N/C) increased the explained variability by 22% in κ relative to bulk mass concentrations alone, improving model R^2 from 0.28 to 0.50 at 0.2% S_c and reducing CCN underestimation by ~11%. Elemental ratios contributed more strongly to κ than bulk aerosol species, indicating that heteroatom-containing organic aerosol substantially influences hygroscopicity. In addition, further analyses show that predictive skill decreased with increasing supersaturation, partly due to size mixing as activation shifted toward smaller particles, which are less well-represented when using bulk composition for hygroscopicity predictions. Hygroscopicity predictions were consistently poorest for bimodal size distributions, indicating that compositional differences between modes reduce the ability of bulk submicron composition to represent the particles controlling activation. Broad accumulation mode distributions showed the strongest composition-κ relationships at low S_c, whereas broad Aitken distributions exhibited the highest correlations at high S_c. O/C contributions decreased with increasing S_c, consistent with higher O/C associated with larger accumulation mode particles, while the contribution of total organic mass increased with S_c as activation shifted toward smaller organic-rich particles. These results demonstrate that aerosol oxidation state and particle size both affect CCN activity and that incorporating elemental composition from high-resolution aerosol mass spectrometry substantially improves predictions of aerosol hygroscopicity in coastal environments.

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2CC.28

Investigating Marine Aerosol Populations and Cloud Condensation Nuclei over the Northeast Pacific Using Autonomous Ship-Based Measurements During BEACONS.

VERONICA BERTA, Lynn M. Russell, Derek Coffman, Hanna Best, Timothy Bates, Raghavendra Krishnamurthy, *Scripps/University of California San Diego*

In-situ observations of aerosols and clouds remain limited over the oceans, hindering understanding of the evolution of marine aerosols in the atmosphere and aerosol-cloud interactions. The Boundary Layer Exploration of Aerosols and Clouds ON Ships (BEACONS) provides an opportunity to address this gap by deploying autonomous aerosol and cloud instrumentation aboard commercial vessels operating along routine shipping routes across the northeast Pacific. A suite of autonomous instrumentation provides continuous measurements of aerosol size distributions, cloud condensation nuclei (CCN), and cloud properties. Here we focus on aerosol size distributions and CCN to investigate seasonal variability in marine aerosol populations, identify signatures of cloud processing in open-ocean aerosol size distributions, and examine the relationship between aerosol size distributions and CCN populations. The routine commercial shipping operations provide sustained observations across diverse meteorological conditions, establishing a long-term observational record that extends beyond the limitations of traditional ship-based research campaigns.

2IA.1

Finite Size Effects and Breakdown of Ensemble Equivalence in Indoor PM2.5 Systems.

Buddhi Pushpawela, ISHIKA SINGH, Isabella Brooks, *The University of Alabama in Huntsville*

In our previous study, we demonstrated the usefulness of canonical and grand canonical ensembles in describing $PM_{2.5}$ aerosol behavior in indoor environments. However, most statistical mechanical treatments assume thermodynamic equivalence between ensembles, an approximation that may not remain valid in confined finite systems such as enclosed indoor spaces. In this study, we investigate the breakdown of ensemble equivalence in indoor $PM_{2.5}$ systems using statistical mechanics and finite-size thermodynamics. Unventilated indoor environments are modeled using the canonical ensemble, while ventilated environments are represented using the grand canonical ensemble, allowing particle exchange with the surroundings.

The analysis focuses on how finite room volume, ventilation rate, and particle concentration influence thermodynamic fluctuations and deviations between ensemble predictions. Using partition function formulations, we derive expressions for entropy, internal energy, particle number fluctuations, and concentration variance under both equilibrium constraints. Simulated $PM_{2.5}$ concentration profiles are used to evaluate the sensitivity of thermodynamic observables to confinement and ventilation conditions. Particular attention is given to fluctuation behavior in low-volume and weakly ventilated environments, where deviations between canonical and grand canonical predictions become increasingly significant.

Our results suggest that ensemble equivalence may break down in confined indoor aerosol systems due to enhanced finite-size effects and particle-number fluctuations. The study demonstrates that the choice of statistical ensemble can substantially affect the predicted thermodynamic behavior of $PM_{2.5}$ in realistic indoor conditions. This work provides a theoretical framework for understanding aerosol stability and fluctuation dynamics in finite environmental systems and highlights the importance of finite-size statistical mechanics in indoor air quality modeling.

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2IA.2

Isothermal-Isobaric Versus Grand Canonical Descriptions of Indoor PM2.5 Fluctuations Under Variable Ventilation.

Buddhi Pushpawela, ISABELLA BROOKS, Ishika Singh, *The University of Alabama in Huntsville*

Indoor $PM_{2.5}$ exposure is a major environmental health concern due to its association with adverse respiratory and cardiovascular outcomes. Indoor particle concentrations are strongly influenced by ventilation, occupancy, particle transport, and environmental conditions, leading to significant temporal fluctuations that are often not fully captured by traditional deterministic models. In this study, indoor $PM_{2.5}$ dynamics in a ventilated room are investigated using a statistical thermodynamics framework based on ensemble theory. Simulated $PM_{2.5}$ concentration time series are generated to represent particle emission, removal, deposition, and air-exchange processes under controlled thermodynamic conditions.

Two statistical ensembles are examined: the isothermal-isobaric (NPT) ensemble and the grand canonical (μVT) ensemble. The NPT ensemble represents a quasi-equilibrium indoor environment with approximately constant temperature and pressure and relatively weak particle exchange, while the μVT ensemble describes an open system with variable particle number resulting from continuous exchange with the surrounding environment. Ventilation rate is treated as a primary control parameter governing the degree of system openness and fluctuation intensity.

The effects of meteorological parameters, including relative humidity and outdoor particle forcing, are further incorporated to investigate how environmental conditions influence aerosol thermodynamic behavior. Increased humidity enhances particle growth and concentration variability, while stronger outdoor forcing promotes nonequilibrium fluctuations through enhanced particle exchange. At low ventilation rates and weak environmental forcing, $PM_{2.5}$ behavior exhibits quasi-equilibrium NPT-like characteristics with relatively narrow concentration distributions and reduced fluctuations. As ventilation and environmental coupling increase, the system progressively transitions toward grand canonical behavior characterized by broader probability distributions, stronger temporal fluctuations, and enhanced variability in particle concentration.

Statistical properties including concentration variance, probability density distributions, and temporal autocorrelation are analyzed to quantify the transition between quasi-equilibrium and open-system regimes. The results demonstrate that ventilation and meteorological conditions jointly govern the statistical behavior of indoor aerosols and can induce fluctuation-driven transitions between distinct thermodynamic regimes. This study highlights the potential of ensemble-based approaches for probabilistic indoor air quality modeling and provides a theoretical framework for improved exposure assessment and ventilation-control strategies in built environments.

2IA.3

Longitudinal Patterns of Synergistic Environmental Quality in Educational Settings: Thermodynamic Conditions, Ventilation Performance and PM Exposures in K-12 Classrooms.

DORIAN SCHWARTZ, Nasim Ildiri, Kristina Petrov, Anna Segur, Mark Hernandez, *University of Colorado Boulder*

The indoor environmental quality of educational settings impacts the health, comfort, and academic performance of students throughout their educational lifetimes. In this context, comprehensive datasets of critical environmental determinants from school settings remain limited. In response to this paucity, high-resolution (minute averaged) longitudinal observations of respirable particulate matter (PM), thermodynamic factors, and fresh air exchange were juxtaposed to corresponding outdoor meteorological conditions and attendance records in large mountain west public school districts. This was enabled by leveraging a large network of calibrated monitors installed school classrooms across Colorado's front range, which have been operating for 2 years. The network collects continuous PM, temperature, humidity, and carbon dioxide (CO_2) measurements from thousands of occupied classrooms, a subset of which have been augmented with radiant globe thermometers. Ventilation performance is assessed as effective fresh air exchange derived from CO_2 profiles; thermal stress is assessed by integrating psychrometric state enthalpy, accounting for in-situ radiance and room air velocities; cumulative respiratory PM exposures is assessed by separately integrating $PM_{2.5}$ and PM_{10} during occupied periods as indicated by CO_2 profile. This approach enables comparisons of co-occurring thermal and respiratory exposure across a variety of building types, occupancy patterns, and seasonal conditions. The analysis focuses on identifying synergistic patterns in PM exposures and thermal stress conditions using machine learning, normalizing for ventilation performance and occupancy. Analysis identifies classrooms with relatively high cumulative PM exposures in a horizon of thermal stresses that may (or may not be) related to ventilation performance. The study demonstrates a cost-effective path to leverage a new generation of indoor monitors that can support larger scale epidemiological and academic performance studies, based on localized high-resolution observations of building performance and occupant exposures.

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2IA.4

Sensor Transfer Strategy to Calibrate Low-Cost Particulate Matter Sensors: Investigating the Performance of Several Low-Cost and Mid-Cost Sensors. JALIL MOKHTARIAN MOBARAKEH, Meghan Megowan, Sara Jones, Perry Hystad, Molly Kile, Parichehr Salimifard, *Oregon State University*

Various calibration methods have been explored for low-cost particulate matter (PM) sensors, and past studies suggest on-site methods outperform others. However, on-site calibrations are under-evaluated. Sensor transfer strategy is one possible on-site calibration method suggested by EPA, where a sensor with known characteristics is co-located with a reference sensor and then moved to the location of each low-cost sensor for short co-location tests. In this study, eight on-site co-location tests were conducted in eight rooms across four buildings at Oregon State University. Each co-location test lasted five hours, and a smoke generator with wood chips was used to generate PM concentrations across six stages from very low (0-10 $\mu g/m^3$) to extreme (>237.5 $\mu g/m^3$). The test was designed to collect at least 20 data points for each concentration stage. In each test, one reference sensor (TSI Optical Particle Sizer 3330), one low-cost sensor (PurpleAir), and six other low- to mid-cost sensors as transfer sensor candidates (Q-track, Alphasense R2, Alphasense N3, IC-Sentinel, AtmoTube, and AtmoCube) were used. Six of the eight co-location tests were used as training sets to develop calibration for the transfer sensors. The calibrated transfer sensors were then used to calibrate the low-cost sensor at the two test locations, comparing the transfer sensors' performance with that of the reference sensor. Based on preliminary results, N3 and R2 showed average R^2 of 0.94 and 0.92, and average RMSE of 28.9 and 37 $\mu g/m^3$, respectively. Given the range of PM mass concentrations covered, the transfer sensors showed potential to serve as a reference sensor in on-site co-location tests. The performance of the calibrated transfer sensors will be further evaluated using test data. Findings of this study can reduce the need for a reference sensor for on-site calibration and provide more insight into potential sensors for sensor transfer strategy.

2IA.5

Optimizing Sensor Placement for Whole-House PM2.5 Exposure Estimation: A Combinatorial Analysis of a Multi-Zone Residential Network. Nikhil Sachidanandan, MARINA VANCE, *University of Colorado Boulder*

Indoor $PM_{2.5}$ exposure varies from room to room, yet most low-cost sensor (LCS) deployments place only one or two units per home. The objective of this work was to determine the optimum number of sensors and their placement using the CASA campaign dataset. We measured $PM_{2.5}$ concentrations at 2-min resolution across 11 zones of the NIST Net-Zero Energy Residential Test Facility. We define the room-volume-weighted $PM_{2.5}$ mean across all zones as the reference exposure. Every sensor group subset, with k (1 - 11) sensors was evaluated against the reference using normalized RMSE on 3 days of cooking experiments (n = 1,978 observations). Best-placement NRMSE scales sharply with k: 53.8% (k = 1), 29.9% (k = 2), 18.2% (k = 3), 14.5% (k = 4), 10.8% (k = 5). The optimal 3-sensor configuration—Kitchen + Basement + Living Room—appears in every optimum with k>=3. Including the basement was mathematically required because of its relatively large volume, representing 42.3% of the house and its low correlation with other zones (r = 0.5 - 0.86), meaning that no other sensor proxies it well. The median NRMSE across all 165 three-sensor subsets is ~56%, driven by second-floor redundancy (five sensors with pairwise r > 0.99). Three thoughtfully placed sensors — one each for the source zone, the large-volume zone, and a primary occupied zone — outperform random networks of nearly any size. House geometry alone can yield a recommendation for residential deployment, without the need for on-site optimization. Future work will couple microenvironmental exposure with likely time activity patterns in US homes to further optimize and contextualize these results.

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2IA.7

Particle Characterization of Indoor Surface Dust Collected from Surviving Houses near a Wildland-Urban Interface (WUI) Fire. ZHONG-MIN WANG, Jeff Wagner, Kazukiyo Kumagai, Suzaynn Schick, *California Department of Public Health*

The series of fires that broke out along the wildland-urban interface (WUI) in Los Angeles, California, USA in January 2025 caused lasting regional environmental effects 1. This work describes analyses of dust collected using direct tape-lift sampling, within 10 homes located either within islands of unburned structures in the burned area or within 3 blocks of the edge of the burned area in Altadena, CA. The samples were qualitatively characterized using Scanning Electron Microscopy/Energy Dispersive Spectroscopy (SEM/EDS) to determine particle morphology and elemental composition. Toxic elements identified included lead, chromium nickel, zinc, cobalt, manganese, and copper. Some samples also contained fibers consistent with asbestos and fiberglass. In 5 of the 8 lead-containing samples, the lead was present primarily as submicrometer, spherical particles that are likely to have been vaporized at high temperature, consistent with the conditions prevailing in the 2025 fires. Some Pb particles were associated with chlorine, potentially from burned PVC. Other metals that were observed as submicrometer particles included chromium, nickel, zinc, copper, and cobalt. In the remaining instances, the particles were 10-100 times larger, non-spherical, and may represent fragments of paint or building materials. Asbestos and glass fibers were found more frequently in homes that survived in islands surrounded by burned homes, than the homes that were located outside the burned area. These SEM/EDS analyses are not comparable to outdoor air, water, or soil screening levels or standards and thus cannot be used for risk assessment. However, the toxics characterized inside these WUI homes can inform future public health planning and monitoring.

2IA.8 – INVITED

Indoor and Outdoor PM2.5 and CO Measurements in Chilean Homes Heated with Wood, Pellet, and Kerosene Systems. BLANCA ESTELA RÍOS RAMOS, Oscar Loyola Valenzuela, Maximiliano Lopez, Darlyn Tapia, *Universidad Mayor*

Residential heating is an important source of fine particulate matter ($PM_{2.5}$) and carbon monoxide (CO) exposure during winter, particularly in cold-climate regions where combustion-based heating is widely used. However, direct measurements inside homes remain limited in many Latin American settings, making it difficult to distinguish indoor emissions from outdoor pollution infiltration. This study will present wintertime indoor and outdoor air quality measurements in Chilean dwellings using wood, pellet, and kerosene heating systems.

We will deploy a previously developed and laboratory-calibrated low-cost sensor network during the Chilean winter heating season. Portable sensor units, designed to measure $PM_{2.5}$, CO, temperature, and relative humidity, will be used in repeated two-week deployments. In each home, two sensors will be installed indoors, one in the main heated living area and one in a bedroom, while a third sensor will be placed outdoors near the dwelling to characterize background concentrations and indoor/outdoor gradients. Homes using wood, pellet, and kerosene heating will be monitored simultaneously when possible, allowing comparison under similar meteorological conditions.

The campaign will quantify pollutant concentrations, peak events, indoor/outdoor ratios, room-to-room differences, and temporal patterns associated with heater ignition, fuel handling, ventilation, and household activity. Particular attention will be given to identifying whether elevated indoor $PM_{2.5}$ and CO are driven by direct indoor emissions, outdoor infiltration, or a combination of both. By comparing three common residential heating technologies, this work will provide exposure-relevant evidence on how household heating choices influence indoor aerosol concentrations and acute CO risk.

These results will support future evaluations of heating interventions, ventilation practices, and community-scale indoor air quality monitoring strategies in wintertime residential environments.

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2IA.9

Cotton Clothing as a Dynamic Reservoir Driving Re-Emission of Indoor Gaseous Chemicals Across Spaces. YUNFEI JIA, Jenna Ditto, *Washington University in St. Louis*

Clothing can act as a temporary reservoir for organic compounds indoors, facilitating their transport across indoor environments through reversible adsorption and desorption. While the partitioning between indoor gaseous species and common fabrics is increasingly being characterized in laboratory settings, field measurements remain limited, especially across indoor environments with distinct emission characteristics. In this study, we deployed cotton fabric coupons in five indoor environments with distinct air composition: a commercial kitchen, a gym, a classroom, a machine shop, and an occupied apartment. Following exposure in each environment to indoor ambient gases and particles, fabrics were transferred to a glass chamber for desorption under ambient conditions, and the composition of off-gassing chemicals was measured using proton transfer reaction-mass spectrometry (PTR-MS) and thermal desorption-gas chromatography-mass spectrometry (TD-GC-MS). Different chemical profiles are observed for fabrics deployed in each environment type, reflecting distinct indoor air compositional signatures across environments. Fabrics from the commercial kitchen showed elevated levels of cooking-related emissions, characterized by carbonyls, furans, and hydrocarbons. In contrast, siloxanes were elevated in fabrics from high-occupancy environments (e.g., the gym and the classroom), consistent with personal care product emissions. Aromatics were generally comparable across environments, except for benzene, which showed elevated levels in classroom-exposed fabrics. For each coupon, temporal decay patterns differ across chemical classes and individual structures, with acids and $C_{>9}$ carbonyls exhibiting slower decay than other classes and homologs, respectively, revealing compound-specific desorption kinetics. Complementary active sampling was conducted in each environment using adsorbent tubes and $PM_{2.5}$ samplers to characterize airborne gas- and particle-phase compositions, respectively, *via* TD-GC-MS.

Variations in the identity and abundance of airborne chemicals across environments are therefore expected to alter cloth-air partitioning equilibrium as individuals move between spaces, driven by compound-specific differences in adsorption affinity and desorption kinetics. These findings will ultimately demonstrate that clothing functions as a dynamic reservoir and secondary emission source capable of redistributing indoor gases across spaces, with implications for chemical exposure, gas-particle partitioning, and multiphase chemistry.

2IA.10

Degradation of Tobacco-Specific Nitrosamines on Indoor Surfaces Induced by Ozone. XIAOYANG LIU, Haofei Zhang, *University of California, Riverside*

Tobacco-specific nitrosamines (TSNAs), formed from tobacco alkaloids, are known as carcinogenic marker compounds for thirdhand tobacco smoke (THS). They can accumulate on indoor surfaces and pose potential health risks. However, their chemical transformation pathways and interaction with unsaturated lipids on indoor surfaces remain poorly understood. Here, we investigate the heterogeneous ozonolysis of surface-bound 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK), an abundant TSNA, both in the absence and presence of unsaturated surface lipids, such as squalene, a major component of human skin oil, or cooking oils. NNK and lipid films were prepared on glass discs and exposed to controlled ozone concentrations under environmentally relevant conditions. The decay of parent compounds was monitored, and transformation products were characterized using complementary mass spectrometry techniques. Kinetic analysis was used to compare NNK degradation in the absence and presence of unsaturated lipids and to evaluate the role of surface-mediated oxidation chemistry. Toxicological assays and QSAR-based modeling were further applied to assess potential changes in environmental fate and health relevance following NNK transformation. Minimal NNK degradation was observed in the absence of unsaturated lipids, whereas unsaturated lipid ozonolysis enhanced NNK decay and led to the formation of oxidation products consistent with reactions involving unsaturated lipid-derived reactive intermediates. These results suggest that unsaturated lipids can alter the persistence and transformation pathways of TSNAs on indoor surfaces. These findings highlight the importance of surface-mediated chemistry in determining the indoor fate and potential toxicity of TSNAs.

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2IA.11

Indoor Aerosol Formation from VOC Autoxidation: A Coupled CFD–Chemistry Study. Donghyun Rim, SUWHAN YEE, *Pennsylvania State University*

Indoor air chemistry involves complex interactions among airflow, pollutant transport, and chemical reactions; however, most existing models rely on well-mixed assumptions that overlook spatial heterogeneity. In this study, a computational fluid dynamics (CFD) framework was developed to investigate secondary organic aerosol (SOA) formation from occupant-emitted volatile organic compounds under ozone-driven oxidation. The model incorporates multi-step autoxidation pathways while resolving spatial variations in airflow and species transport. The results show that particle formation exhibits strong spatial variability governed by airflow patterns and oxidation time scales. At early times, particle concentrations remain relatively uniform because multi-step reactions delay particle formation. At later stages, however, low-volatility products accumulate and produce pronounced spatial gradients. A strong correlation is observed between nanocluster aerosol concentration and age of air, with elevated concentrations occurring in regions with longer residence times. These findings demonstrate that airflow-driven reaction timescales and pollutant accumulation play dominant roles in indoor particle formation. They also highlight the importance of coupling chemical kinetics with spatial transport processes to accurately predict indoor air chemistry and human exposure.

2IA.12

Germicidal Far-UVC Lamps with Cooking, Cleaning, and Personal Care Products in an Office. TAEHYUN PARK, Tyson Berg, Morgan Selby, Jose Hernandez, Jienan Li, Delphine K. Farmer, *Colorado State University*

Germicidal far-UVC lamps with peak emission at 222 nm (GUV_{222}) have emerged as a promising indoor disinfection technology for pathogen control in occupied spaces. At the same time, its use may also influence indoor chemistry through the formation of ozone and other reactive oxidants.

The Secondary Chemistry of Far-UV Technology (SCOUT) Project examined the effects of GUV_{222} on indoor aerosol formation during common indoor activities in a real office environment. Experiments were conducted for surface cleaning, personal care product use, and cooking under control, GUV, and O_3 addition conditions. Quaternary ammonium-based cleaning products and some personal care products induced new particle formation (NPF) and particle growth. In some cases the GUV condition produced more persistent growth and larger final particle sizes than O_3 addition alone. Air-fryer cooking generated strong particle emissions under all conditions, indicating that the cooking activity itself dominated indoor particle exposure more strongly than the incremental effect of GUV_{222}. Fan operation substantially reduced the particle formation and growth observed during GUV_{222} cleaning experiments, suggesting that air circulation can mitigate GUV_{222}-related secondary aerosol formation. These results indicate that the indoor use of GUV_{222} should be considered not only in terms of pathogen control, but also in terms of activity-dependent chemical reactivity and changes in aerosol exposure.

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2IA.13

Assessing the Relative Impacts of Burning Different Wood Species with Varying Moisture Content in a Wood Stove on Indoor Air Quality in Cold Climate Regions. ABHISHEK SINGH, Srijan Aggarwal, Raghu Betha, Jenno Joseph-Leenose-Helen, *University of Alaska - Fairbanks*

Indoor air pollution resulting from residential wood stove pollution has been studied in detail, but the combined effects of wood species and moisture conditions in influencing the indoor aerosol characteristics and potential respiratory impacts remain insufficiently understood. In this study, we examined the relative impacts of three commonly found wood species in Alaska – Spruce, Birch and Cottonwood, and analyzed their impact on indoor air in a dry cabin under three moisture conditions – Kiln-dried, Seasoned and Wet-mix. Fuel moisture showed a dominant effect on the emissions, with Kiln-dried wood producing high particle number concentrations and early-burn peaks. Wet-mix conditions suppressed number emissions and shifted particle-size dynamics. Spruce emitted the highest number of particles, whereas Cottonwood showed the most dynamic size shifts, and strongest BC-PM coupling, and Birch demonstrated greater pulmonary deposition under wetter conditions.

2IA.14

Multi-Parameter Characterization of Indoor Air Quality in an Oklahoma Medical Cannabis Cultivation Facility. Hongwan Li, YAO YANG, *University of Oklahoma Health Campus*

The legal cannabis industry has expanded rapidly in the United States, but continuous indoor air quality (IAQ) data from cannabis cultivation facilities remain limited, particularly in states where industry growth has outpaced occupational health infrastructure. This pilot study characterized multi-parameter IAQ and potential occupational exposure determinants in an active medical marijuana cultivation facility in Central Oklahoma. Continuous monitoring was conducted from July 10 to August 1, 2023, in a 2,000 ft2 (186 m2) HVAC-equipped indoor cultivation facility housing approximately 900 plants. Seven instruments were deployed at breathing-zone height across three spatial zones: three Aranet4 NDIR CO2 sensors, two TSI AirAssure multi-parameter monitors measuring CO2, CO, NO2, O3, SO2, total volatile organic compounds (tVOC), and size-resolved particulate matter, and two PurpleAir PA-II-FLEX particle counters measuring PM1, PM2.5, and PM10. Descriptive statistics, hourly summaries, inter-sensor correlations, and cross-platform comparisons were used to characterize temporal patterns, spatial heterogeneity, and episodic excursions.

CO2 exhibited a distinct diurnal pattern associated with the plant light/dark cycle. Aranet4 mean CO2 concentrations ranged from 979 to 1,086 ppm, with maximum values exceeding 2,200 ppm; correlations within the Aranet4 cluster exceeded r=0.996, indicating minimal spatial heterogeneity for CO2. Median PM2.5 concentrations were low across platforms (1.4-3.1 ug/m3), but short-duration spikes reached 30,070-34,953 ug/m3 on TSI monitors and 4,656-5,010 ug/m3 on PurpleAir sensors. tVOC concentrations were spatially asymmetric, with means of 1.42 and 3.61 mg/m3 and 95th percentiles up to 15.19 mg/m3. Indoor temperatures reached 41.2 degrees C, and relative humidity reached 99-100%. These findings show that cannabis cultivation facilities can present dynamic, multi-hazard aerosol and gas-phase exposure environments requiring task-resolved monitoring, exposure controls, and cannabis-specific occupational health guidance.

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2IA.15

A Data-Driven Systematic Review of Outdoor and Indoor Air Quality During Wildfire Smoke Events: Infiltration and Effective Mitigation Strategies. MD. ALINUR RAHMAN, Daud Nosham, Josephine Lau, Nishit Shetty, *University of Kansas*

Wildfire activity has intensified globally in recent decades, contributing to severe degradation of both ambient and indoor air quality (IAQ). Although numerous studies have investigated wildfire smoke (WFS) emissions, atmospheric transport, health impacts, and mitigation approaches, there remains a lack of a systematic synthesis of the literature focused specifically on WFS exposure within built environments. Existing reviews have largely relied on narrative and semi-structured approaches, limiting the systematic evaluation of WFS exposure, thematic overlaps, and critical knowledge gaps.

This study presents a data-driven systematic review of WFS impacts on IAQ, human health, and mitigation strategies. A transparent and reproducible literature screening framework was implemented using three scientific databases: SciFinder, Web of Science, and PubMed. Our search strategy retrieved a total of 1,283 journal papers, which were subsequently narrowed to 137 U.S.-based studies after applying predefined exclusion criteria, with an additional 10 relevant studies incorporated through complementary searching. The collected studies were categorized into three major categories and seven interconnected subcategories: WFS emission characteristics, composition and physical properties, transport and aging, infiltration mechanisms, indoor air quality impacts, human health impacts, and mitigation strategies. A binary classification matrix was developed to quantitatively evaluate thematic relationships and compare reported PM2.5 concentrations extracted from 68 papers.

We synthesized reported PM2.5 concentrations associated with WFS across the contiguous United States and generated a heatmap illustrating the geographic distribution of studies. This review further identifies major research gaps related to WFS transport into indoor environments, associated PM2.5 exposure levels, and their impacts on IAQ. By transforming qualitative literature into analyzable data, this work advances WFS review methodology and provides a reproducible framework for evaluating multidisciplinary research on IAQ and public health during WFS events. The review synthesizes evidence-based mitigation strategies for maintaining healthier built environments under increasing WFS exposure scenarios.

2IA.16

Long-Term Simultaneous Monitoring of Indoor and Outdoor PM1.0, PM2.5, and PM10 in the San Francisco Bay Area. KAYCIE NUCKLES, Christopher J. Hogan, *University of Minnesota*

Sources of particulate matter (PM) are present both indoors and outdoors, yet the majority of studies focus on its role in these environments separately rather than on their relationships with one another over sustained periods of time. To explore the correlation between indoor and outdoor PM concentrations, PM1.0, PM2.5, and PM10 concentrations were recorded simultaneously inside and outside a Bay Area home using low-cost Alphasense OPC-N3 and Purple Air sensors. Simultaneous measurements were made from December 2025 to June 2026 and binned to estimated PM1.0, PM 2.5, and PM10 concentrations. In January 2026, the outdoor PM 2.5 concentration was found to exceed 15 micrograms per cubic meter for the majority of the measurement period; however, indoor concentrations only exceeded this threshold during a single, transient event. Fewer high-concentration PM 2.5 events were observed in the Spring months, and we also found qualitatively improved correlation between indoor and outdoor particle mass concentrations during this period. Cross-correlation analysis was performed to quantify the strength of the relationship between indoor and outdoor PM concentrations in greater detail. This study utilizes methods that can be effectively employed in residential, commercial, and industrial settings in a minimally invasive manner, enabling simultaneous assessment of indoor and outdoor air quality, as well as identification of outdoor particle penetration to the indoors, indoor PM sources, and the effectiveness of ventilation and filtration. All of these features can be quantified through simultaneous monitoring of particle size distributions in co-located outdoor and indoor spaces.

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2IA.17

Using Particle Size Distribution for Indoor Source Identification: A Neural Net Method. KAI-CHUNG CHENG, Gan Huang, *San Diego State University*

Variation in aerosol sizes between indoor sources offers potential for source identification. We collected example size profiles for smoking, cooking, dusting, and other common indoor emissions under controlled experimental settings. Besides particle number concentration, we used particle surface and volume concentrations as model input features to predict sources. Artificial Neural Net (a machine learning method) was applied to identify non-linear patterns across different sizes (0.3-10 µm) and concentration types (number, surface, volume) for source classification. Using a high-precision research-grade optical particle sizer (OPS 3330) that measures 16 particle sizes, the neural net model achieved ~98% accuracy in predicting four source classes (compared to <70% for multinomial logistic regression). We tested how well the machine learning source identification method (neural net) can be applied to one widely used consumer-grade aerosol monitor (PurpleAir Zen) that measures 4 particle sizes (0.5–1, 1–2.5, 2.5–5, 5–10 µm) as well as volatile organic compounds (VOC). Preliminary results suggested that source identification can be achieved, using size-resolved particle measurements of low-cost PurpleAir sensors (e.g., F-scores >96% in differentiating 7 indoor source classes).

2IA.18

Remediating Thirdhand Smoke in Gypsum Wallboard: Coatings vs. Ozonation. XIAOCHEN TANG, Marion Russell, Hugo Destaillats, *Lawrence Berkeley National Laboratory*

Thirdhand smoke (THS) contaminants deeply embedded in indoor materials present a severe limitation to standard remediation strategies as sorbed volatile and semi-volatile organic compounds (VOCs/SVOCs) act as long-term reservoirs that continuously re-emit into indoor air. This study evaluates the efficacy of two common remediation interventions—surface coatings and ozonation—at abating THS emissions from contaminated gypsum wallboard. Square wallboard specimens were masked on all sides except the indoor-facing surface and equilibrated in a conditioning chamber under controlled temperature, relative humidity, and continuous airflow. Baseline nicotine emission rates were monitored via sorbent tubes coupled with gas chromatography-mass spectrometry (GC/MS) until steady state was reached. To evaluate coating efficacy, specimens were treated with either conventional indoor paint or a specialty odor-removing paint. To evaluate chemical remediation, uncoated specimens were exposed to parts-per-million (ppm) levels of ozone for 1 to 5 hours, simulating commercial odor-control treatments. Post-intervention emissions were tracked over several months to assess long-term efficacy. Preliminary results indicate that the specialty odor-blocking coating significantly outperforms conventional paint by physically or chemically retaining THS constituents, reducing nicotine emission fluxes by >70%. Conversely, while ozonation rapidly decreased nicotine emissions through oxidation, the mitigation effect was short-lived, with emissions rebounding over time. These findings provide a quantitative framework for selecting optimal, long-term remediation strategies to mitigate THS exposure risks in heavily contaminated indoor environments.

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2IA.19

Far-UVC Fluence Rate Controls Sub-10 nm Nanoparticle Nucleation and Growth During Household Cleaning with a Limonene-Based Product. BRIAN MAGNUSON, Shohoria Afrin Shorno, Ernest Blatchley III, Nusrat Jung, Brandon E. Boor, *Purdue University*

Far-UVC radiation (222 nm) is an effective means of airborne pathogen control and is considered less hazardous to occupants than conventional 254 nm germicidal UV, but it photolytically generates O_3. Indoors, reactions between this O_3 and VOCs emitted by scented products form secondary organic aerosol, creating a trade-off between pathogen control and respiratory exposure. Surface disinfection with scented cleaning products releases terpenes such as limonene that are highly reactive toward O_3 and may therefore promote nanoparticle nucleation and growth under Far-UVC irradiation. This study evaluates how nanoparticle nucleation and growth dynamics during full-house cleaning with a limonene-based product are affected by Far-UVC fluence rate. Field experiments were conducted in the Purdue zEDGE Test House with ceiling-mounted KrCl* excimer lamps providing whole-room exposure. A spray-and-wipe cleaning routine was performed at fluence rates from 0 to 0.77 μW cm^{-2}, varied by changing the number of lamps operating, all below current occupational exposure limits. Size-resolved nanoparticle number concentrations from 1.25 to 582.9 nm, spanning the sub-3 nm nanocluster aerosol regime, were measured in real-time with a high-resolution particle size magnifier–scanning mobility particle sizer (PSMPS). VOCs and indoor O_3 were monitored to track precursor vapor depletion and oxidant availability. Indoor O_3 rose from below 5 ppb to approximately 20 ppb across the fluence rate range. Size-integrated number concentrations between 1.25 and 100 nm increased from ~2×10^6 to ~4×10^8 cm^{-3} with increasing fluence rate, and mode-fitting analysis yielded growth rates that also increased with fluence rate, reaching ~200 nm h^{-1}. These results show that even modest Far-UVC fluence rates can drive intense indoor nanoparticle formation during routine cleaning, and motivate further work on how cleaning product composition governs this response.

2IM.1

Comparative Performance of an Orbitrap MS and an APi-TOF MS for the Analysis of Aerosol Nanoclusters. COLLEEN MILLER, Paulus Bauer, Véronique Perraud, Ivo Neefjes, Dina Alfaouri, Yosef Knattrup, Avery Dalton, Jonas Elm, Nanna Myllys, James Smith, *University of California, Irvine*

New particle formation (NPF) is an important atmospheric process in which new aerosols are generated and grow through various processes. Aerosol nanoclusters in the 1–3 nm size range play an important role in NPF; however, due to instrumentation limitations and potential fragmentation and evaporation during analysis, their chemical characterization remains elusive. In this work we investigated methanesulfonic acid (MSA)–amine nanoclusters generated using a bipolar electrospray source, mobility-selected with a high-flow Half-mini differential mobility analyzer and chemically characterized using either an Orbitrap mass spectrometer (Orbitrap MS) or an atmospheric pressure interface time-of-flight mass spectrometer (APi-TOF MS). Two different amines were probed: methylamine (MA) and 4-aminobutanol (4AB). For both systems, the Orbitrap MS demonstrated substantially higher transmission (up to 6%) compared to the APi-TOF MS (up to 0.5%), which allowed for a more sensitive detection of these nanoclusters. The majority of the clusters observed in positive ion mode were singly charged clusters in the form of a neutral (MSA, amine)n unit (n = 1–12) attached to a protonated [amine+H]+ ion for both systems. However, the comparison between the two instruments revealed that the Orbitrap MS induced significantly less fragmentation, with acidic MSA-rich clusters appearing more abundantly in APi-TOF MS mass spectra due to decomposition through loss of an amine molecule. Statistical fragmentation modeling of the MSA–MA system within the APi-TOF MS validated these experimental observations, successfully predicting survival probabilities and fragmentation pathways for this system. These results demonstrate the importance of the selection of mass analyzer in nanocluster characterization as well as provide an instrumentation option that can study atmospheric cluster formation with minimal fragmentation effects.

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2IM.2

Integrated Design and Performance Assessment of a Compact Cyclone-Virtual Impactor Band-Pass Sampler for Submicron Aerosol Collection. SUMAN DEWANJEE, Vikas Goel, Nipun Thamatam, Gabriel Isaacman-VanWertz, Masoud Agah, *Virginia Tech*

Portable size-selective aerosol sampling at low volumetric flow rates remains a significant challenge for personal exposure monitoring, occupational health assessment, and submicron aerosol characterization. While miniature cyclones provide robust coarse particle removal, achieving precise and tunable size fractionation within the submicron accumulation mode with low pressure drop remains difficult. This work presents the design, fabrication, simulation, and experimental characterization of a compact, precision-machined miniature cyclone, along with its integration into a cyclone–virtual impactor (CVI) platform for band-pass aerosol separation. The cyclone was fabricated via CNC machining from 6061 aluminum alloy with a 4.85 mm body diameter, 1.62 mm inlet, and ~26 mm height. Computational Fluid Dynamics simulations using COMSOL Multiphysics were conducted to predict internal flow behavior and particle trajectories. Simulations indicate strong vortex formation enabling effective removal of particles >1 µm while maintaining smaller particles in the flow stream. Experimental validation using polydisperse caffeine aerosols (0.35–3.5 µm), measured with a Scanning Electrical Mobility Spectrometer (SEMS) and GRIMM optical particle spectrometer, demonstrates a 50% cut-off diameter (D_{50}) of 0.9–1.2 µm at flow rates of 0.6–1.0 L/min, with good agreement between simulations and measurements. Building on this validated cyclone design, the system enables incorporation of additional flow paths to support virtual impactor operation for selective exclusion of fine particles. We will examine the potential for a coupled cyclone–virtual impactor configuration that defines both upper and lower particle size bounds, enabling tunable band-pass fractionation in the 0.5–0.9 µm range. This integrated approach provides a compact, low-pressure-drop foundation for advanced size-selective aerosol sampling, with applications in personal exposure monitoring, occupational health, and bioaerosol studies.

2IM.3

AVL Condensation Particle Counter Characterisation. VICTORIA FRUHMANN, Helmut Krasa, Markus Knoll, Martin Cresnoverh, Johannes Murg, Alexander Bergmann, *Graz University of Technology*

The AVL condensation particle counter (CPC) was characterized for various test aerosols, condenser temperatures, and working fluids to investigate the influence of supersaturation and particle composition on counting performance. Higher supersaturation levels, generated by increasing the temperature difference between saturator and condenser, reduced morphology- and composition-dependent effects on counting efficiency. Measurements included tube-furnace-generated Ag and NaCl particles, spark soot, combustion-generated soot, and WOx particles.

For n-butanol, the CPC was characterized at five different temperature settings to investigate the influence of supersaturation on counting performance. The experimental results were compared with CFD simulations using a 2D axially symmetric COMSOL model of the AVL CPC. Flow, temperature, and saturation fields were simulated, and counting efficiency curves were calculated using homogeneous and heterogeneous nucleation theory following Fletcher, assuming perfect wetting. The simulations reproduced the experimentally observed trends.

In addition to n-butanol as a reference working fluid, several alternative working fluids (propylene glycol, dimethyl sulfoxide (DMSO), isopropanol, and decane) discussed in the literature were investigated. Since wick wettability is critical for CPC operation, the interaction of these fluids with the wick material was evaluated. Only isopropanol and decane showed wetting behaviour comparable to that of n-butanol.

In order to determine the effect of different working fluids on the activation and growth of particles with different chemistries and morphologies in the CPC, the saturator and condenser temperatures were set to achieve d_{50} values of 10 and 23 nm for Ag particles. Preliminary findings indicate that decane is less influenced by particle chemistry and morphology compared to the other working fluids studied.

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2IM.5

Performance Evaluation of Community-Level Air Quality Monitors in Urban and Rural Settings in New Jersey, USA.

SEYEDEH REYHANEH SHAMS, Jackie Park-Albaum, John Evangelista, Clinton J. Andrews, Jie Gong, Sunyoung Kim, Deborah Plotnik, Jennifer Senick, Gediminas Mainelis, *Rutgers, The State University of New Jersey*

In our ongoing study, we deployed a network of 12 community-level air quality monitors (MODULAIR, QuantAQ) across Elizabeth, New Jersey, USA, and conducted colocation studies to evaluate sensor performance across contrasting environments. One MODULAIR unit was co-located with a New Jersey Department of Environmental Protection (NJDEP) regulatory station in urban Elizabeth, near a major highway intersection, while three additional units were co-located with an NJDEP station at the Rutgers University agricultural campus, approximately 25 miles south, in a rural setting. Urban co-location data were collected from July 8, 2024, to May 3, 2026; rural co-location data spanned June 18 to September 12, 2025.

Correlation analyses were performed for CO, NO_2, O_3, PM_1, $PM_{2.5}$, PM_{10}, temperature, and relative humidity. The three rural co-located MODULAIR monitors demonstrated strong internal consistency, with correlation coefficients generally above 0.93 for gaseous pollutants and particulate matter and approaching 1.00 for meteorological variables. $PM_{2.5}$ and O_3 showed excellent agreement among the three units ($r = 0.99$ for both pollutants), and NO_2 also correlated strongly ($r = 0.96$).

Comparisons with NJDEP reference instruments revealed some environment-dependent performance. At the rural site, MODULAIR O_3 measurements aligned closely with NJDEP observations ($r = 0.94$; RMSE = 6.88 ppb), while NO_2 showed weak agreement ($r = 0.25$). $PM_{2.5}$ correlations were moderate to strong ($r \approx 0.8$). At the urban site, MODULAIR–NJDEP correlations for $PM_{2.5}$ and NO_2 were similar to the rural site ($r = 0.78$ and $r = 0.24$, respectively), whereas O_3 correlations were somewhat weaker ($r = 0.77$). Data collection is ongoing, and the correlation datasets will be updated.

The results so far demonstrate excellent MODULAIR sensor-to-sensor consistency and highlight the importance of applying local calibration or adjustment when using non-regulatory monitors for community-scale air quality assessment.

2IM.6

Indoor PM2.5 Prediction Using a Mass Balance-Informed Deep Learning Model.

Lam Khang Nguyen Duy, Minh T.N Nguyen, Thanh H. Nguyen, Dung D. Le, Phong Thai Khanh, Hung Hai Pham, Vishal Verma, NHAN DINH NGO, *VinUniversity, Hanoi, Vietnam*

A robust prediction of indoor $PM_{2.5}$ is vital for proactive interventions of indoor air quality (IAQ) and public health management. However, previous research has often validated models against datasets representative only of low-level concentrations (10 - 90 $\mu g/m^3$), leading to a lack of generalizability across diverse IAQ conditions. Furthermore, these approaches were restricted to using outdoor $PM_{2.5}$ as the sole environmental predictor, thus missing the opportunity to leverage the ample amount of indoor climate data which is generally easily available. This study aims to develop a mass balance-informed framework for the prediction of indoor $PM_{2.5}$ concentrations using multiple indoor and outdoor environmental parameters.

The framework was developed by embedding a discretized mass balance equation (MB) into a Bidirectional Long Short-Term Memory (BiLSTM) model, resulting in a MB-Informed BiLSTM model. Four datasets representing distinct IAQ conditions were curated using low-cost sensors. One dataset reflects the normal conditions ($PM_{2.5} < 90$ $\mu g/m^3$), while the remaining three represent the highly-polluted scenarios ($PM_{2.5} > 100$ $\mu g/m^3$). The MB-Informed BiLSTM model was trained on the normal condition dataset and validated across both normal and extreme indoor air pollution scenarios.

The framework achieved exceptional predictive performance ($R^2 \simeq 0.99$) across all scenarios, including highly-polluted environments. These findings suggest that integrating MB constraints with deep learning can facilitate the development of reliable, low-cost proactive IAQ monitoring systems.

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2IM.7

Single Particle Analysis of Model Human Respiratory Aerosols with In-Situ Transmission Electron Microscopy. MARTIN AHN, Alex Hall, Akua A. Asa-Awuku, Taylor J. Woehl, *University of Maryland, College Park*

Single particle analysis techniques are powerful tools that can provide valuable insights towards key physical and chemical aerosol properties that are frequently lost via bulk measurements. Conventional single particle methods, such as electrodynamic balance (EDB), have been used to probe micron-scale aerosol droplets to characterize their phase state, morphology, and water uptake behavior. Using these techniques, previous works have investigated the physical and chemical properties of bioaerosols, namely model human respiratory aerosols (HRA), to better understand their drying properties in relation to airborne virus transmission. However, due to size limitations, many of these works have only been able to probe the super-micron size ranges. HRAs are known to emit multimodally from human respiratory systems via vocal activity and pose concerns due to their potential as carriers of viruses, such as influenza A, SARS-CoV-2, and rhinovirus. While super-micron sized droplet studies provide meaningful information for a subset of HRAs, the drying mechanisms and resulting morphologies of the sub-micron size regime remains poorly understood. Using a novel in-situ transmission electron microscopy (TEM), this work aims to study drying behavior and morphology of nanoscale model HRA particles (~300 nm). HRAs are modelled using 1:1, 10:1, and 100:1 mass ratio of bovine submaxillary mucin (BSM) and sodium chloride (NaCl) to mimic the hypersecretion of mucins that have been reported as a result of respiratory viral infections. By complementing the live videos of these aerosol models with other TEM characterization tools like energy dispersive spectroscopy (EDS) and 4D scanning transmission electron microscopy (4DSTEM), nano-scale behaviors and features can be further studied to reveal morphological, chemical, and crystallographic properties of these model aerosols.

2IM.8

Laser-Induced Incandescence Uncertainty Quantification for Soot Sizing in Time-Resolved Measurements Using Variance Decomposition. EVANGELOS K. STEFANIDIS, Mark McKinnon, *UL Research Institutes-Fire Safety Research Institute (FSRI)*

Ultrafine soot particles (<100 nm) play a central role in aerosol exposure, transport, and health effects. However, inferring their primary size using Laser-Induced Incandescence (LII) is highly sensitive to uncertainties in model formulation and poorly constrained parameters. This study performs a global sensitivity and identifiability analysis on a time-resolved LII model to determine which uncertain parameters dominate variability in predicted LII emission and particle temperature, and how these uncertainties propagate into soot primary particle diameter inference. We employ generalized polynomial chaos (gPC) surrogate modeling and variance-based Sobol indices to evaluate two formulations of the LII model, a comprehensive “full” model that includes absorption, conduction, radiation, sublimation, oxidation, annealing, and thermionic emission, and a simplified “reduced” model incorporating only absorption, conduction, radiation, and sublimation. Analyses are conducted over laser fluences from 0.03 to 1 J/cm² for 33 nm soot particles heated by a 532 nm laser pulse in a heated synthetic-air bath. Two uncertainty scenarios are examined, namely a uniform ±10% variation around nominal parameter values and literature-derived parameter ranges reflecting real material variability. Dominant sources of output uncertainty shift with both laser fluence and time. At low fluences and early times, absorption-related parameters exert the greatest influence on LII signals, whereas at higher fluences and post-pulse times, uncertainty is primarily governed by parameters associated with multi-photon saturation and mass-loss processes (e.g., sublimation and photodesorption). Including additional physics (annealing and oxidation) in the full model further elevates the impact of the vacancy migration activation energy as a contributor to uncertainty. Finally, an error-propagation analysis shows that inferring particle size from LII emission yields consistently lower uncertainty than using particle temperature across both model formulations and uncertainty scenarios, supporting time-resolved emission-based LII as a more robust pathway for soot primary particle sizing in aerosol-relevant regimes.

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2IM.9

Simplified Aerodynamic Sizing for Coarse Particles. SUSANNE HERING, Stavros Amanatidis, *Aerosol Dynamics Inc.*

Increasingly, low-cost sensors are used to map airborne particle concentrations. Most commonly particles are measured by optically based sensors. Yet the response of these instruments inherently depends on particle refractive index, a quantity which is generally not known. In the coarse size range, aerodynamic sizing is an attractive alternative. Not only does aerodynamic sizing remove the dependence on refractive index, it is the parameter of interest for lung deposition and atmospheric transport. Further, estimates of suspended particulate mass based on aerodynamic sizing depend on the square root, rather than the first power, of the assumed particle density.

Presented here is a simplified approach for aerodynamic sizing of ambient aerosols. As with other aerodynamic sizing instruments, our approach characterizes particle aerodynamic diameter by time-of-flight in an accelerating air flow. Particles are confined to the centerline of a flow that is sharply accelerated through a nozzle, and particle velocity is measured immediately downstream of the nozzle exit. Larger particles, which have greater inertia as compared to their aerodynamic drag, cannot follow the rapid change in air speed, and their velocity lags that of the airflow. This is the operating principle of the TSI Aerodynamic Particle Sizer which uses sheath flow to direct particles to the centerline, and measures the transit time between two points defined by a crested illuminating laser. Our approach employs two simplifications: (1) we use aerodynamic focusing to direct particles to the centerline of the flow and (2) particle velocity is characterized simply by the transit time of the particle across a single, Gaussian shaped laser beam. These simplifications yield a much smaller instrument package, albeit a less precise measurement than that of the TSI instrument. Laboratory data with a prototype of this simplified design show that the increase in the relative transit time with aerodynamic diameter agrees with that expected from numerical modeling. Aerosols of differing material density (1.06 and 2.55 g/cm3) fall on a common calibration curve of transit time vs. aerodynamic diameter. Aerodynamic sizing with this simplified system was within 3.3% on average of the TSI Aerodynamic Particle Sizer, with maximum deviation of ~9%. Precision, expressed as the relative standard deviation (σ/μ), was on the order of 9% in the >5μm range.

2IM.10

Autonomous Low-Cost Ozone and PM2.5 Sensors to Study Spatiotemporal Distribution and Exposure in the Central Valley in California. AKSHAY KUMAR GUNNIAH VIJAYAKUMAR, Shantanu Jathar, Torria Colpitts, *Colorado State University*

Ozone (O3), a criteria air pollutant, is often overlooked in rural and remote regions, leaving the spatial distribution and exposure levels poorly understood, particularly in underserved communities. In this study, we developed and deployed a network of 12 (2023) and 6 (2025) autonomous, low-cost, and solar-powered air quality monitoring units (VOZboxes) in California's San Joaquin Valley (SJV). Co-located with a reference monitor in Fresno, CA, the VOZboxes underwent calibration before and after field deployment in the months of June and November for 2023, months of June and October for 2025, to measure O3 concentrations over a dynamic range of 20 to 100 ppbv with an RMSE < 5 ppbv and PM2.5 concentrations of 0 to 80 μg/m3. Deployed across 11 unique locations in SJV from July to November 2023 and 6 unique locations in SJV from July to November 2025 at varying periods, the VOZboxes revealed modest spatial variability in O3 mixing ratios, with elevated concentrations recorded in bigger cities and smaller eastern townships, while lower concentrations were found in smaller western regions over the two measurement years. By leveraging multivariate regression models for data calibration, which use ambient temperature and a temporal variable to calibrate the O3 concentrations with each VOZbox requiring its own individual calibration each year, the VOZboxes effectively assessed compliance with the national ambient air quality standard (NAAQS) for O3 (maximum daily 8-hour average(MDA8) of 70 ppbv) across locations. The VOZboxes were able to capture the difference in MDA8 values at the same location between years within 6 ppbv. Similar calibration models were developed for both PM sensors in each unit, providing additional insight into the air quality conditions of the valley; however, the health-based standard for PM2.5 is defined as an annual average concentration of 9 $\mu g/m^3$, which would require longer-term deployments to adequately assess, particularly since PM2.5 concentrations are typically highest during the winter months, unlike O3, which peaks during the summer. This study underscores the potential of low-cost environmental sensors for characterizing air quality and O3 exposure in rural and remote environments. Additionally, it emphasizes their utility as tools for addressing the monitoring needs of underserved communities and acts as a tool for environmental justice.

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2IM.11

Development of an Offline Aerosol Mass Spectrometry Method for Organic Aerosol Characterization in a Globally Distributed Surface Particulate Matter Network. YUXUAN REN, Randall Martin, Jhao-Hong Chen, Christopher Oxford, Brent Williams, Rodney J. Weber, Lu Xu, *Washington University in St. Louis*

Global measurements of organic aerosol (OA) concentrations and chemical composition remain limited and unevenly distributed. While monitoring networks, including the globally distributed Surface Particulate Matter Network (SPARTAN), provide an established framework for measurements, their current methodologies do not fully support comprehensive OA characterization. Aerosol Mass Spectrometry (AMS) is widely used for real-time OA composition measurements, but its cost, complexity, and logistical requirements limit long-term, multi-site online deployment, particularly at the global scale. Here we develop and evaluate an offline AMS methodology to characterize OA in particulate matter collected on Teflon filters routinely used by monitoring networks. Using a commercial ultrasonic nebulizer coupled with a syringe pump, this offline methodology is highly reproducible, requires small extract volumes (2 mL), offers low detection limits (1.7 µg OA and 0.43 µg sulfate per filter), and achieves higher nebulization efficiency than previous methods. We evaluate this offline AMS methodology by co-located online AMS observations. We find that oxygenated OA is effectively recovered (64 ± 28 %) while the recovery is lower for hydrocarbon-like OA due to its limited water solubility. This approach offers new capability for SPARTAN and is readily adaptable to other monitoring networks. Its application across networks will broaden the spatiotemporal coverage of AMS-based OA measurements and improve methodological and instrumental consistency to support ongoing efforts to build a long-term, globally consistent OA dataset.

2IM.12

Assessing the Performance of the Teledyne Model T640/X Alignment Factor in Climate-Distinct Regions Across the United States. KEELIE N. STEINER, Benjamin A. Nault, Peter F. DeCarlo, *Johns Hopkins University*

Teledyne recently adopted an alignment factor for its Teledyne Advanced Pollution Instrument (TAPI) Model T640 with 640X option (denoted T640/X) to address systematic differences between the T640/X and Federal Reference Method (FRM) mass concentrations. The alignment factor, based solely on temperature and mass concentration, adds an empirical layer to an already proprietary correction, raising uncertainty about what it corrects for. Due to variability in aerosol physicochemical properties and meteorology across the United States, the universal applicability of the alignment factor for federally regulated fine particulate matter ($PM_{2.5}$) mass concentration is uncertain. To evaluate the alignment factor's performance, data from the T640/X and collocated FRMs were analyzed in six climatically distinct U.S. sites from 2017-2022. These results were compared with U.S. Environmental Protection Agency (EPA) FRM-FEM equivalency criteria. While the alignment factor does improve agreement between the T640/X and FRM, most results fail to meet EPA criteria. Performance noticeably varies by site, and these discrepancies were investigated in terms of regulatory design values (DVs) and local meteorological conditions. These findings suggest that the alignment factor is not applicable across differing climates, and due to the observed differences, the FEM status should be reevaluated.

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2IM.13

Twelve Year Summary of Particulate Matter Sensor Performance Evaluations. WILTON MUI, Namrata Shanmukh Panji, Noel Ruiz, Xiaobi M. Kuang, Brandon Feenstra, *South Coast Air Quality Management District*

The Air Quality Sensor Performance Evaluation Center (AQ-SPEC) program at South Coast Air Quality Management District (South Coast AQMD) has evaluated upwards of 96 triplicates of particulate matter (PM) air quality sensors that measured PM_1, $PM_{2.5}$, and/or PM_{10} mass concentrations. Drawing on over 12 years of accumulated knowledge from PM sensor evaluations, we provide a comprehensive summary of PM sensor performance, with an emphasis on understanding key factors influencing measurement accuracy. We examine how environmental conditions affect observed sensor responses, with particular focus on humidity and coarse particulate matter. In addition, sensors are evaluated against multiple established performance standards to understand current state of sensor performance from a standards-based perspective. Finally, we explore future directions for AQ-SPEC, including the feasibility of adoption of established performance standards into AQ-SPEC methods and deliverables. The findings in this historic reanalysis of PM sensor performance can provide insight for community scientists and public agencies to inform sensor selection decisions for community air monitoring projects and sensor library loan programs.

2IM.14

Air Across Texas: An Educational Program on Air Quality Using Low-Cost Sensors for High School Students from Across Texas. KARIN ARDON-DRYER, Jessica Spott, Rodolfo Hernandez, Melodie Martinez-Manahan, Allison Eubanks, Tiberio Garza, *Texas Tech University*

Air Across Texas (AAT) is a National Science Foundation (NSF) funded project that introduces atmospheric science topics to upper-level high school students from across Texas, with a focus on first-generation students from rural areas. The project's goal is to support and advance student engagement and interest in STEM fields, particularly those related to atmospheric sciences and air quality. The program focuses on different central aspects of their STEM education: STEM interest and self-efficacy, parental awareness of STEM concepts, college experiences, and STEM careers through collegiate belonging. The AAT program adopts hands-on project-based learning that enables students to learn how to apply a research-based approach when encountering challenging scientific concepts or subjects. AAT has four phases, which include virtual and in-person settings, emphasizing parallel active learning and teamwork. In the first phase, students are introduced, via virtual sessions, to different scientific topics to increase their knowledge and prepare them for the next phase of the project. During the second phase, student activities focus on research learning. Each student conducts a research-based project using a low-cost air quality sensor placed in the student's home. The third phase is a Summer Research Symposium (SRS) week at Texas Tech University (TTU) campus. SRS engages students in social and scientific activities, workshops, and talks to prepare them for college life. Students work on their university applications and prepare posters summarizing their research activities (of phase 2). Parents/guardians also participate at the beginning of SRS, learning about potential STEM careers, collegiate opportunities, and ways to support their students. At the end of this week, students present their research (air quality with my low-cost sensors) in a conference setting. Students and Parents/guardians then come again to TTU in the fall (phase four), where students present their research poster at the TTU Transformative Undergraduate Experiences Symposium. This presentation aims to introduce AAT and highlight findings from our first-year student cohort.

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2IM.15

Detecting Oleic Acid + NO3 Aerosol Reaction Products with Mid-IR Dual Comb Spectroscopy in a Novel, Laser-Coupled Aerosol Chamber. LEO BLOXHAM, Anna Ziola, Douglas A. Day, Anne V. Handschy, Garrett Mathews, Alyssa Lalko, Kevin Williamson, Amanda Makowiecki, Masayuki Takeuchi, Daven Henze, Satoshi Takahama, Paul Ziemann, Gregory Rieker, Jose-Luis Jimenez, *University of Colorado Boulder*

The rapid, chemically-specific detection of aerosols is of great interest to atmospheric chemistry research due to aerosol human health hazards and their effects on climate forcing and visibility. Functional group analysis of aerosols is commonly done by collecting particles on a filter, then characterizing the sample using Fourier Transform IR spectroscopy (FTIR) under a non IR-absorbing atmosphere. However, this method typically limits temporal resolution to hours/days for ambient concentrations. Real-time analysis of aerosols with FTIR is hampered by the interferences with major atmospheric constituents such as CO2 and H2O. The SAURON project team has developed a method for real-time, open-path mid-infrared spectroscopic analysis of aerosols, using dual comb spectroscopy (DCS). The very high spectral resolution (<0.003 cm-1) of DCS allows quantitative subtraction of absorption from interfering vapors (e.g. CO2 and H2O). A novel stainless steel 119 L cylindrical aerosol chamber was constructed and characterized for testing this technology. The constructed chamber includes a long, unobstructed optical path length (3.14 m round-trip), multiple rapid aerosol generation methods, a fan for fast mixing (90% homogenous in 7 seconds), and online submicron-to-supermicron particle size distribution measurements. The well-understood reaction between oleic acid aerosols and nitrate radicals was selected and produced inside the aerosol chamber. The chemical reaction was characterized with traditional online (SMPS, AMS) aerosol instrumentation and offline FTIR filter samples. The DCS lasers were able to detect the formation of nitrated aerosol products of this reaction with 1 second time resolution. This demonstrates the applicability of the DCS system for detecting the oxidation of unsaturated organic particles and the potential for elucidating other aerosol-phase reactions.

2IM.16

A Gas Chromatograph-Chemical Ionization Mass Spectrometer for Isomer-Resolved, Field-Deployable Measurements of Airborne PFAS. CHENYANG BI, Yufan Hu, Joji Sherman, Michael Davern, Mitchell Alton, Anita Avery, Nathan Kreisberg, Barbara Turpin, John Jayne, Jason Surratt, Manjula Canagaratna, *Aerodyne Research, Inc.*

Per- and polyfluoroalkyl substances (PFAS), often referred to as “forever chemicals,” are widely used as water-resistant coatings and surfactants in a range of consumer and industrial products. PFAS represent a broad class of compounds with diverse functional groups and heavily fluorinated carbon chains. Their industrial synthesis often results in mixtures of structural isomers (e.g., linear and branched forms) due to similarities in chain-based structures and the lack of stereochemical constraints during production. These structural isomers can exhibit significant differences in their fate, transport, and toxicity, making isomer-specific analysis essential. While chemical ionization time-of-flight mass spectrometry (CI-TOF-MS) has been used for real-time detection of PFAS in air, it is unable to resolve isomers and is typically calibrated only for the linear-chain isomer of each PFAS class. Consequently, techniques that enable isomer-resolved molecular characterization are essential for understanding the atmospheric fate and transport of individual PFAS isomers. In this study, we couple a thermal desorption aerosol gas chromatograph (TAG) with a modified sampling inlet, which enables sample preconcentration and isomer separation, with a CIMS using iodide as the reagent ion to measure gas-phase PFAS species. The TAG-CIMS enables the switch between real-time CIMS analysis and isomer-resolved gas chromatograph analysis. After calibrating with authentic compounds for various PFAS chemical classes, we demonstrate the instrument performance for gas-phase PFAS measurements in the field by deploying the TAG-CIMS in a textile manufacturing facility.

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2IM.17

Nozzle-Based Method for the Breakup of Solid Aerosol Clusters. DARREN CHENG, Miranda Hack, V. Faye McNeill, *Columbia University*

Stratospheric aerosol injection (SAI) is a proposed climate intervention which aims to reduce some of the most harmful effects of climate change by injecting aerosols into the stratosphere. Several recent SAI modeling studies have shown that the injection of solid aerosol particles such as calcium carbonate and alumina instead of sulfate could lessen side effects such as ozone depletion and stratospheric heating associated with SAI. However, many uncertainties remain, including heterogeneous uptake coefficients, and the feasibility of creating and dispersing monodisperse, ideally sized (~400 nm diameter) particles at the scales needed to impact global climate. While laboratory-based studies may be used to investigate the uptake of trace stratospheric species onto solid aerosol, or the coagulation of solid aerosol within a dispersion plume, there is a lack of methods that can generate a steady supply of ideally sized and monodisperse particles. Current aerosol generation methods produce particles that are larger than modeled particles, rely on clusters of smaller particles, or cannot produce a steady concentration of particles. Variations in particle surface area, morphology, or packing density may result in confounding artifacts in measurements of chemical uptake or aerosol microphysics. Here we present a new method to break up solid aerosol using a previously described aerosol generator connected to a vacuum generator and custom-manufactured nozzle. Various operating parameters including flow speeds, nozzle geometries, and bulk aerosol size and composition were explored. Shifts in aerosol size distributions were observed using a scanning mobility particle sizer and an aerodynamic particle sizer. Particle morphologies were visualized using filter collection and a scanning electron microscope. Results indicate that the custom nozzle successfully breaks up large clusters, yielding particles that more closely resemble those used in SAI climate models for laboratory characterization experiments.

2IM.18

Trajectory-Based Monitoring Network for Identifying the Causes of Air Pollution. DANIEL HLADKÝ, Vladimíra Volná, *Czech Hydrometeorological Institute*

The poster presents the results of the Trajectory-based Monitoring Network research project, which was supported by the Technology Agency of the Czech Republic. The project aims to design an intelligent autonomous system for aerosol sampling that is controlled using near-real-time air mass trajectory calculations. The system software activates the samplers only when the calculated trajectory corresponds to a predefined transport pathway.

Wind direction is a key factor in identifying the causes of air pollution in a given location. However, wind direction measurements at a given location may differ significantly from the trajectory leading from the pollution source to that measurement point (orography and built-up areas). If we want to focus on the impact of a specific source on pollution at a given location, it is useful to analyze only those situations that correspond to the air mass pathways from that source to the measurement site. This method saves significant amounts of money on samples and costly laboratory analyses, and it also makes the statistical evaluation more objective.

The concept also opens up further monitoring possibilities, such as differential sampling of pollution levels upstream and downstream of a selected pollution source, thereby determining its contribution to ambient air pollution. In such cases, the samplers located upstream and downstream of the source are active only if the trajectory of the aerosol particles forms a line connecting both sampling points and the source under evaluation. The pair of samples collected by this pair of samplers will thus always represent the difference caused by the source under evaluation.

The system is based on low-cost hardware consisting of a Raspberry Pi server and Arduino client units communicating via the GSM network using the MQTT protocol. Near-real-time trajectories are calculated by the TRAMONE server using wind data from the Czech National Climatological database.

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2IM.19

Investigating the Relative Humidity-Dependence of Effective Particle Density for Model Aerosol Systems. MIA KAUFFMAN, Cara Waters, Evan Dalton, Andrew P. Ault, *University of Michigan*

The two main approaches to measuring aerosol concentrations are mass-based (μg m^{-3}) and number-based (# cm^{-3}), with number-based providing better size resolution, but mass being the metric on which regulations are based. Aerosol effective particle density (ρ_{eff}) measurements are needed to accurately convert particle number concentrations (N_p) to particle mass concentrations (m_p). Current ρ_{eff} values may lead to inaccurate atmospheric m_p estimations because they are commonly based off dried particles (relative humidity, RH < ~ 15%) and ignore any influence from changes in RH and aerosol liquid water content (ALWC). Some inorganic aerosol (e.g., ammonium sulfate) experience RH-dependent phase changes which can significantly impact ρ_{eff}. These inorganic aerosol particles are typically solid at low RH (< ~ 30%), liquid at high RH (> ~ 80%), and supersaturated or supercooled roughly between ~ 30% to ~ 80% RH. Several instruments have been utilized to calculate ρ_{eff}; however, direct ρ_{eff} measurements as a function of RH/ALWC are lacking. This study simultaneously measures size-resolved m_p with a quartz crystal microbalance (QCM) cascade impactor (100 nm to 35 μm in aerodynamic diameter) and size-resolved N_p with a scanning mobility particle sizer (SMPS, 15 to 700 nm in electrical mobility diameter) to measure the ρ_{eff} of model inorganic aerosol as a function of RH/ALWC and mixed inorganic/organic aerosol systems. Our results show the QCM cascade impactor's ability to directly quantify m_p by quantifying the difference in resonant frequencies (Δf) of two piezoelectric quartz crystals (sensing and reference crystal) as particle impaction decreases the sensing crystal's resonant frequency. Additionally, the relationship between ρ_{eff} and RH/ALWC and the inclusion of organics on ρ_{eff} was investigated for isoprene-epoxydiols secondary organic aerosol (IEPOX-SOA). This study demonstrates the need to account for RH in ρ_{eff} calculations for improved atmospheric m_p predictions.

2IM.20

Computational Integrated CFD and Experimental Evaluation of RASA and Reference Sampler Location-Based Performance in a Large Wind Tunnel. DMITRI KUCHEROV, John Cate, Sunil Kumar, Ahmad Kalbasi-Ashtari, Michael Omana, Maria King, *Texas A&M University*

Liquid uranine aerosols (LUAs) with nominal sizes of approximately 5, 10, and 15 μm were generated using a flow focusing monodisperse aerosol generator (FMAG) and introduced into a two-story, high flow volume wind tunnel to evaluate the performance of a radionuclide aerosol sampler/analyzer (RASA), (1000 m^3/h), alongside two pyramidal isokinetic air samplers (PIAS). In addition to experimental testing, computational fluid dynamics (CFD) modeling was used to examine how the placement of the PIAS affects airflow behavior and sampling accuracy within the system. Four different PIAS configurations relative to the RASA inlet were analyzed. The CFD results showed that Configurations 1 and 2 noticeably altered the airflow, directing it toward the RASA inlet and creating conditions that could lead to biased measurements. In comparison, Configurations 3 and 4 produced more uniform flow patterns with less interference, although Configuration 4 showed minor interaction with the RASA flow field. These trends were consistent with the experimental data, where collection efficiency decreased with increasing particle size (93.4%, 74.8%, and 55.7% for 5, 10, and 15 μm, respectively) at configuration 3, while wall loss increased (6.6%, 25.2%, and 44.1%) and transmission ratio decreased for configuration 3 (optimal configuration). General results indicate that sampler placement has a significant impact on airflow and particle transport within the system. Among the configurations tested, Configuration 3 provided the most stable conditions by minimizing flow disturbance. Results suggest that modifications to the RASA geometry, particularly in the inlet and internal ducting, could help reduce wall losses and improve sampling performance.

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2IM.21

Improved Quantification of CCN Measurements by Gaussian Peak Fitting of Drop Size Distributions. SOURITA SAHA, Lynn M. Russell, Darrel Baumgardner, Greg Roberts, Markus Petters, Richard Leaitch, Elisabeth Andrews, *Scripps Institution of Oceanography*

Measurements of Cloud Condensation Nuclei (CCN) rely on activating and detecting droplets, but instrument configuration introduces uncertainty in their accuracy, especially during operation at remote locations. Here we propose a correction technique to reduce biases in droplet size distributions measured by a DMT CCN-100 instrument that affect quantification of CCN concentration. The correction fits a Gaussian peak to better represent activated particle number concentration at low supersaturation (also filtering out times with unresolved peaks) and excludes unactivated particles detected due to degraded optics at high supersaturations. For a multi-year dataset from Utqiaġvik, Alaska, for which the first-stage voltage (FSV) increased during unattended operation, the correction improved the measured CCN/CN ratios to be physically consistent across aerosol populations with similar composition and showed good agreement with measurements in ideal operating conditions. The correction also recovers instrument performance for calibrations with high FSV. Overall, the Gaussian method improves low-supersaturation CCN measurements under ideal conditions and corrects for optical degradation at high supersaturations.

2IM.22

Fluorescence-Based Photothermal Infrared Spectroscopy Methods for the Detection of Aerosolized Microplastics and Nanoplastics. RANDI LIBIN-STRAUB, Wilson Chen, Abbygail Ayala, Andrew P. Ault, *University of Michigan*

Detecting and identifying microplastics and nanoplastics (MNPs), especially those with diameters less than 10 µm, is essential for understanding their impact on climate and human health; the majority of atmospheric MNPs are in this size range. Microplastic (MP) studies have largely focused on characteristics of MPs with diameters greater than 10 µm, particularly studies focused on identification via single-particle vibrational spectroscopy. Vibrational spectroscopy identifies functional groups, making it a powerful tool for MNP identification. However, there are key limitations, including the potential for signal in Raman microspectroscopy to be overwhelmed by fluorescence, and the poor spatial resolution of traditional infrared (IR) spectroscopy.

Optical photothermal infrared spectroscopy (O-PTIR) addresses both issues by using both visible and infrared light to detect photothermally-induced changes to the refractive index of a sample. By using a counterpropagating configuration, the O-PTIR spatial resolution has been improved to include particles less than 400 nm.

Two recently developed fluorescence-based photothermal IR techniques can utilize MNP autofluorescence, enabling IR measurements of smaller particles. The first, fluorescence-guided O-PTIR (FL-O-PTIR), provides targeted selection of fluorescent particles for IR analysis, significantly increasing throughput, especially in complex environmental mixtures. The second method, widefield fluorescence-detected photothermal IR (FL-PTIR), simultaneously collects the spectra of all points within a field of view. When IR light is absorbed, the localized heating causes changes in fluorescence intensity. These changes are measured to produce a hyperspectral IR image.

This study marks the first time fluorescence-based PTIR methods identified aerosolized MNP particles. Spectra were collected from a variety of aerosolized MNPs, including polyethylene, polypropylene, and polystyrene, as well as proxies of atmospheric species. These results demonstrate the efficacy of these techniques for identifying fluorescent atmospheric MNPs in complex mixtures with improved size resolution, helping address the need for methods to identify sub-micron plastics in the atmosphere and broader environment.

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2IM.23

Dynamic Shape Factors and Electron Tomography for the Assessment of Submicron Aerosol 3D Morphology. BRUNO LOYOLA SAN MARTIN, Martin Ahn, Akua A. Asa-Awuku, *University of Maryland, College Park*

Describing the shape of submicron particles is of paramount importance in fields such as nanoparticle engineering and atmospheric aerosol science. A large share of a particle's properties depends on its morphology, which dictates cross-sectional areas in particle flows and surface-to-volume ratios. These parameters heavily influence drag forces and adsorption onto the particle's surface, respectively. Dynamic shape factors (χ) and 3D electron tomography (ET) are well-established methods for particle shape characterization in their respective disciplines, aerosol science and microscopy. This work aims to describe the relationship between both approaches, considering the quantitative nature of shape factors and the qualitative information a 3D tomograph can provide. While theoretical χ values have been calculated for symmetric 3D aerosol shapes and aggregates of identical spheres, experimental data is required to understand the effect of surface irregularities and particle/flow orientation on χ for 3D shapes with cross-sections that change with particle orientation (e.g. rods). Here, we compare the sensitivity of ET and χ to different aspects of particle morphology, such as sphericity, surface roughness, and particle orientation in flows. Shape factors for atomized aerosol streams are obtained using a tandem Aerodynamic Aerosol Classifier (AAC)–Scanning Mobility Particle Sizer (SMPS) system, and 3D tomographs are generated from 2D Environmental Transmission Electron Microscopy (ETEM) images of individual particles. Atomized kraft lignin particles yield a χ value of 1.05, which is consistent with roughly spherical particle shapes from imaging data. Additional χ and 3D ET comparisons for spherical, cubic, and rod-like shapes are discussed. This combination of shape factor and 3D ETEM measurements provides insight into aerosol properties derived from particle morphology, such as surface-to-volume ratio and aggregation behaviors.

2IM.24

Using Size-Based Classifiers in Tandem to Calibrate and Infer Mixing State with an Aerosol Mass Spectrometer. NISHAN SAPKOTA, Julia Zaks, Anand Kumar, Changda Wu, Timothy Sipkens, Joel Corbin, Allan K. Bertram, Steven Rogak, *University of British Columbia*

The aerosol mass spectrometer (AMS) is widely used to characterize physical and chemical properties of aerosols. Conventional AMS calibration requires ionization efficiency (IE) and particle time of flight (pToF) measurements using mobility classified (d_m) aerosols generated by a differential mobility analyzer (DMA). However, DMA-based calibration is susceptible to multiple charging artifacts, introducing limits in size selection, signal intensity and calibration accuracy. Here, we present an alternative calibration approach using an aerodynamic aerosol classifier (AAC), which selects truly monodisperse particles based on aerodynamic diameter (d_a). Because the AMS measures vacuum aerodynamic diameter (d_{va}), AAC classification provides a more direct physical comparison. We then evaluate the relationship between d_a and d_{va} alongside d_m to quantify AMS response for four different aerosols: polyethylene glycol, ammonium nitrate, ammonium sulfate and fulvic acid, over size range of ~30 – 800 nm. Following the one-dimensional measurement, we operate AMS in tandem with both AAC and DMA to establish a bidimensional (2D) space combining equivalent properties from all three instruments. This enables derivation of 2D effective density with chemical information as a new constraint to better define the aerosol mixing state. The AAC-based classification enables a more robust AMS calibration and combining effective density with chemical speciation provides a new 2D framework for understanding complex aerosol mixture.

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2IM.25

Characterizing CVS Tunnel Background and Measurement Uncertainties for Ultra-Low PM Emissions Using a Low-Cost Wireless Sensor. ISHARA JAYASURIYA, Kevin Denton, Tim Gernant, Sreekesh Kookkal, Suresh Dhaniyala, *Ford Motor Company*

Recent LEV IV, Tier 4, and Euro 7 regulations in the US and EU mandate significantly lower particulate matter (PM) emissions beginning in Model Year 2027/2028. The proposed 0.5 mg/mile PM limit applies to both passenger cars and light-duty trucks. Furthermore, EU standards necessitate Particle Number (PN) concentrations below 6×10^{11} #/km, incorporating a new 10nm detection threshold. Although OEMs expect to achieve these targets using Gasoline Particulate Filters (GPFs), recent empirical data indicates that verifying limits in the 0.5–1.0 mg/mile range is exceedingly difficult using traditional gravimetric methods.
This difficulty stems from managing uncertainties associated with ultra-low mass measurements (8-40µg), which are sensitive to engine type and test conditions. Key contributors to uncertainty include balance instability, electrostatic effects, filter handling, and tunnel background levels. While existing research has addressed PM measurement process errors, accurately quantifying the spatial and temporal contributions of tunnel background remains a significant challenge.

This study evaluates a novel approach to quantifying tunnel background levels and measurement uncertainties by deploying a network of portable, low-cost wireless sensors within the CVS tunnel. Real-time PM mass, PN, and Volatile Organic Fraction (VOF) data are integrated with temperature, pressure, and CO measurements to characterize the inherent background levels within the test cell. Three distinct commercially available sensors were integrated into the TelosAir platform and evaluated across diverse engine operating points. This presentation will detail the measurement principles and provide a comparative analysis against high-fidelity instruments, including the Dekati Mass Monitor (DMM), AVL Particle Counter (APC), and Micro Soot Sensor (MSS).

2IM.26

Flow Imaging Microscopy Method for Rapid and High-Throughput Measurement of Fiber Count and Length Distributions. BON KI KU, Pramod Kulkarni, *Centers for Disease Control and Prevention, NIOSH*

Assessing the distribution of airborne fiber lengths and number counts in air samples is essential for evaluating exposure to asbestos and elongate mineral particles (EMPs) that may pose asbestos-like health risks in workplace environments. Although phase contrast microscopy (PCM; NIOSH method 7400) is commonly used to monitor inhalation exposure to airborne asbestos or EMPs, it has several limitations. PCM cannot accurately count, size, or identify all fibers collected on filters with robust statistical reliability and is both labor- and time-intensive, especially for dilute samples. This study explored the potential of flow imaging microscopy (FIM) as a rapid, high-throughput method for measuring the number count and length distribution of airborne fibers. First, monodisperse polystyrene latex standards, containing microspheres with diameters between 2 µm and 50 µm, were used to evaluate FIM's counting and sizing accuracy at 4X and 10X objective lens magnifications for spherical particles. Next, test glass fibers were prepared in two ways: (i) suspended in deionized water from bulk fiber powder or (ii) aerosolized by vortex shaking of glass fiber powder and collected on cascade mesh micro-screens with varying pore sizes to produce fiber samples of different lengths. Sizing accuracy for spherical particles was verified within the 5-50 µm range, showing differences of less than 13% for 4X magnification and 3% for 10X. For fibers, FIM measurements of length distributions at 10X magnification for geometric mean lengths ranging from 8.0 to 26 µm were reasonably consistent with PCM, showing a 12.4% difference. Comparing fiber density as a function of fiber count showed that the difference between the two methods decreased with higher fiber counts, emphasizing the importance of high-throughput measurement with FIM. The results demonstrate that FIM could be a promising methodology for quantifying airborne fiber measurements, offering a rapid and cost-effective approach while maintaining robust counting statistics.

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2IM.27

Substrate Photochemical Aging Reaction Chamber (SPARC): A New Capability to Study Aging-Induced Physical and Chemical Changes of Organic Aerosols. JILLARD DE FIESTA, Sining Niu, Gregory W. Vandergrift, Alla Zelenyuk, Swarup China, Zezhen Cheng, Yuzhi Chen, *Pacific Northwest National Laboratory*

Organic aerosol (OA) contributes substantially to submicron particle mass and numbers in the atmosphere. Photochemical aging crucially impacts OA lifetime and physicochemical properties including composition, optical properties, viscosity, and hygroscopicity. Here, we present the Substrate Photochemical Aging Reaction Chamber (SPARC), a new counter-top platform dedicated to studying photochemical aging of aerosols collected on a variety of substrates. SPARC features a modular cubic chamber (6” x 6” x6”) with humidity and temperature control, gas lines for introducing photochemical reagents, and an adjustable UV-A LED module. The UV-A LED module is mounted externally on the chamber top and irradiates the internal volume of the chamber through a high-transmittance glass window. A sample plate seated in the center of the chamber accommodates aerosol samples on various collection media. In this presentation, we demonstrate a use case of SPARC by conducting photolytic aging of aerosols impacted on Teflon filters. Three types of aerosol filter samples are generated: (1) single-component aerosol generated from surrogate organic standards, (2) photochemically generated laboratory SOA, and (3) ambient aerosol collected locally and from a remote forested region. Each filter is divided in three cutouts: one for photolysis experiment, one for dark control experiment with light off, and one receiving no treatment. The treated and untreated samples are analyzed by high-resolution mass spectrometry and microscopy technique without additional sample preparation, enabling quantification of photolysis-induced aerosol physical and chemical changes. This new capability is ideal for atmospheric aerosols already collected on substrates and/or for situations in which in situ online photochemical aging is not feasible.

2IM.28

Uncertainties in Quantification of Crystalline Silica in Aerosols Using Infrared Spectroscopy and X-Ray Diffraction Methods. KABIR RISHI, Orthodoxia Zervaki, Bon Ki Ku, Chen Wang, Pramod Kulkarni, *Centers for Disease Control and Prevention, NIOSH*

X-ray diffraction (XRD) and infrared (IR) absorption spectroscopy are widely used to quantify crystalline silica in occupational aerosol monitoring. The analytical figures of merit for both techniques depend on the physical and chemical characteristics of the aerosol particles. Although standard methods account for errors related to spectral overlap and sample mass loading, sources of error stemming from filter-substrate interference, phase purity of the reference material (in XRD), and particle-size-dependent response (in IR) can affect overall measurement uncertainty and have not yet been systematically explored.

Respirable crystalline silica (RCS) particles exhibit pronounced Mie scattering within the spectral regions used in IR transmittance measurements. Theoretical calculations, based on the Lorenz-Mie solution to Maxwell's equations, showed that as particle diameter approached the incident infrared wavelength, the quartz mass derived from IR transmittance depended on particle size, thereby introducing significant uncertainty into mass quantification. These theoretical predictions were experimentally validated using spherical, size-classified polystyrene and quartz particles. The uncertainty arising from size-dependent artifacts was estimated for RCS quantification using representative aerosol size distributions in coal mines, granite processing plants, and construction sites.

We investigated the uncertainties in XRD quantification arising from artifacts related to the phase purity of the calibration standard and the substrate morphology. X-ray attenuation dominates the analytical response for particles larger than 20 µm. Conversely, particle shielding within the fibrous filter matrix and the non-ideal phase purity of the quartz standard reference material influence submicron RCS quantification. By assessing mass-normalized XRD intensities across size-fractionated materials and crystalline silica standards, we probed the uncertainties in NIOSH Method 7500.

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2IM.29

WALL-E Goes Dual: Gas-Particle Characterization of Atmospheric Aerosol by Coupled Chemical Ionization Mass Spectrometry. Imad Zgheib, Sebastien Perrier, Evan Lesne, Manjula Canagaratna, MATTHIEU RIVA, *CNRS-IRCELYON*

Real-time characterization of both gas and particle phases at the molecular formula level is essential for understanding secondary organic aerosol (SOA) formation, composition, and evolution. Classical approaches relying on two separate instruments introduce differences in mass calibration, sensitivity, and detector response that can bias gas-particle comparisons.

Here, we present a dual gas-particle chemical ionization mass spectrometry system built around WALL-E, a particle evaporation interface combining gas-phase removal, thermal desorption, hot sheath-flow protection, thermal isolation, and cooling/dilution prior to ionization, previously validated for particle chemical composition measurements with minimal thermal decomposition artifacts. A gas-phase sampling line and a particle-phase line through WALL-E are mechanically switched upstream of a single chemical ionization source connected to a mass spectrometer with a fast-switching time (~ 10s) ensuring that both phases are ionized and detected under identical conditions. This configuration enables direct, formula-resolved comparison of composition across both phases with minimized instrumental bias. In addition, WALL-E's temperature-scanning capability provides formula-specific thermograms, offering a second, independent route to volatility alongside gas-particle partitioning ratios, allowing the two to be cross-compared and used to mutually constrain volatility parameterizations.

The system was characterized and applied to flow tube experiments on monoterpene ozonolysis. The dual configuration successfully resolved the composition of oxidation products spanning a wide range of oxidation states across both phases, tracked their distribution as a function of volatility, and demonstrated the benefit of constraining volatility through thermogram- and partitioning-derived estimates. These results establish the approach as a versatile platform for SOA characterization, with direct implications for improving the experimental basis of volatility parameterizations in atmospheric models.

2IM.30

Investigating the Relationships Between Gas-Phase Pollutants and PM with a Low-Cost Sensing Network. CHIARA PESCE, MiKyla Harjamaki, Michael Hannigan, *University of Colorado Boulder*

Low-cost sensing (LCS) datasets of particulate matter (PM) and gas-phase pollutants including carbon monoxide (CO), carbon dioxide (CO2) and nitrogen oxides (NOx) have largely been investigated independently across source environments. Few studies examine the relationship between these pollutants in spatially and temporally resolved datasets. Leveraging a LCS monitoring network in Salt Lake County, we characterized the connections between PM and gas-phase pollutants.

Salt Lake County hosts a variety of emissions sources including high-traffic roadways, refineries, and other industrial activities. Air quality analysis is further complicated by the unique geographical landscape of Salt Lake City, as the nearby mountains make it prone to inversions and its proximity to the drying lakebed of the Great Salt Lake introduces hazardous geogenic dust. This analysis of PM and gas-phase pollutant correlation elucidates the complex air quality environment in Salt Lake County.

To improve measurement estimates and minimize sensor bias in the network, robust calibration methodologies were implemented for all studied pollutants. We then investigated enhancements from background to assess covariation between pollutants, while considering how meteorological conditions in Salt Lake County impact pollutant transport and accumulation. This approach demonstrates how spatially dense, multi-pollutant LCS networks can aid in understanding the dynamics of complex air quality environments like Salt Lake County. In future work, this analysis can be used to inform the exploration of potential sources, spatial gradients, and temporal patterns within the dataset.

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2IM.31

The Next Generation of Nano Particle Production: Various Materials and Automated CPC Calibrations with the Silver Particle Generator. MAXIMILIAN DOLLNER, Paulus Bauer, Vinicius Berger, Hans-Joachim Schulz, Adam Boies, Jacob Swanson, *Catalytic Instruments GmbH & Co.KG*

A stable and well-defined aerosol source is essential for quantitative nucleation research, heterogeneous condensation studies, and the calibration of aerosol instrumentation. The evaporation–condensation technique is one of the most widely applied methods for generating nanoparticles from diverse materials [1,2], yet laboratory-specific designs have historically hindered reproducibility across studies. The Silver Particle Generator (SPG) [3] introduces a standardized and highly flexible implementation of this method, enabling consistent nanoparticle production from a large variety of materials [4]. In this work, we explore new dimensions of nanoparticle generation by combining automatic Condensation Particle Counter (CPC) calibration with the SPG and demonstrating the instrument's versatility for producing materials beyond silver.

The SPG facilitates rapid switching between materials using an exchangeable tube-set design that ensures clean operation and repeatable aerosol output. This feature enables the production of plastics, organics, salts, and metals under well-controlled thermal conditions, allowing the generation of defined size distributions and concentrations. We present results of temperature dependent size distributions of different salts, organic materials and metals, such as iron, silver and gold.

Silver is a well-established material for the calibration of CPCs. However, the CPC-calibration procedure still requires many time-consuming manual interventions, which additionally increase the uncertainties of the calibration results. By automating CPC calibration routines with SPG-generated silver nanoparticles the system offers improved reproducibility and a path toward standardized calibration results with minimized uncertainties. These findings highlight the SPG as a robust and versatile platform for standardized nanoparticle production, automated instrument calibration, and advanced studies of heterogeneous condensation and particle growth mechanisms.

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2IM.32

Thermal Pretreatment-Enhanced Optical Contrast for Real-Time Single-Particle Bioaerosol Classification. IN HO KIM, Joon Young Park, Jae Hak Shin, Jae Hee Jung, *Sejong University*

Autofluorescence-based bioaerosol sensors enable real-time single-particle detection but are limited by weak microbial fluorescence and signal overlap between biological and non-biological aerosols. This study evaluates thermal pretreatment as an active signal-conditioning strategy to improve the optical discrimination and classification of bioaerosol particles.

Staphylococcus epidermidis and *Saccharomyces cerevisiae* were thermally treated on quartz substrates, and their fluorescence spectra were measured under 280, 355, and 405 nm excitation. A continuous-flow platform integrating aerosol heating and real-time optical detection was then developed. Aerosolized *S. cerevisiae*, Arizona Test Dust, and cellulose were heated in a tube furnace at 20–400°C and analyzed using a custom laser-induced fluorescence system. Fluorescence (FL) and scattering (SC) signals from individual particles were simultaneously acquired under 405 nm excitation and used for classification with ensemble-learning algorithms.

Thermal treatment produced excitation-dependent fluorescence responses in both microorganisms. Fluorescence decreased under 280 nm excitation but increased substantially under 355 and 405 nm excitation. In the continuous-flow experiments, yeast particles exhibited increased FL and decreased SC signals up to 300°C, whereas dust and cellulose signals remained stable. These contrasting responses reduced overlap in the corresponding SC–FL distributions and improved classification. At 300°C, the gradient boosting model achieved an ROC-AUC of 0.98 and an accuracy of 0.96, compared with 0.87 and 0.80, respectively, at 20°C. Further heating to 400°C reduced performance, indicating an upper operating temperature for thermal conditioning.

These results demonstrate that thermal pretreatment can enhance optical contrast and improve real-time single-particle bioaerosol classification.

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2IM.33

Intercomparison of PM Measurements by the BlueSky Air Quality Sensor and Comparison of Ambient Ozone and Nitrogen Dioxide Measurements with Reference Sensors.
SADIE MORLEY, Zoe Lynch, Erick Mattson, Alina Pantano, J. Alex Huffman, *University of Denver*

This poster will present an undergraduate research project comparing the accuracy and variability of the TSI BlueSky 8145 air quality sensor compared to reference-grade sensors deployed at the Colorado Department of Public Health and Environment (CDPHE) Rocky Flats North (RFN) monitoring site near Denver, Colorado. The BlueSky is a commercially available, low-cost device that integrates electrochemical gas sensors and an optical particulate matter (PM) sensor. Data collected for O3 (2BTech Model 205) and NO2 (2BTech Model 405) monitors were compared with data collected from reference sensors. PM data was also collected using three BlueSky units over 16 months, and intercomparisons between the units will be shown. A discussion will be presented to show the length of time each sensor operated before observing instrument failures that required attention. Gas-phase data was processed using a five-step statistical model to identify sources of error. Results show that the BlueSky electrochemical O_3 and NO_2 channels display strong environmental reactions, cross-sensitivity, and temporal drift. Statistical modeling identified temperature, relative humidity, and redox-window interactions as predictors of sensor response. Calibration models developed in this study demonstrate measurable performance improvements. These findings highlight both the limitations and the potential of low-cost electrochemical sensors and provide a foundation for future calibration-based approaches that may enhance their scientific utility.

2IM.34

Evaluating PurpleAir Flex and SD Sensor Performance for Particulate Matter Monitoring After 2.5 Years of Ambient Deployment at the University of Denvers Kennedy Mountain Campus.
Tatiana Peccedi, Sasha Gisi, Riley Smith, SADIE MORLEY, Ty Kaji, Erick Mattson, Alina Pantano, J. Alex Huffman, *University of Denver*

The poster will be the presentation of an undergraduate research project analyzing the effectiveness of using PurpleAir sensors for low-cost particulate matter (PM) monitoring. PurpleAir sensors offer a feasible solution to supplement networks of expensive instrumentation, despite their technical limitations. Examining the low-cost sensor performance as reliable PM monitoring instruments, this research yields 2.5 years of ambient PM measurments using PurpleAir sensors while comparing differences between two models; the PA-II-SD and PA-II-Flex. Six PurpleAir PM sensors are co-located in pairs (SD and Flex) across three sites at the University of Denver's Kennedy Mountain Campus (KMC) near Red Feather Lakes, CO, and have been deployed for continuous measurements since April 2024. Measurements of PM1, PM2.5, and PM10 have been recorded at 10-minute resolution, along with relative humidity, temperature, and atmospheric pressure. Annual PM trends and meteorologic data were analyzed to assess shifting PM concentrations and the Air Quality Index (AQI) across seasons, characterized by summer peaks and winter lows. Correlation assessments were conducted for SD and Flex models, determining moderate to high agreement (R2 0.77-0.97) between sensor pairs. Further analysis establishes a notable bias across Flex monitors which struggle to distinguish volume at low PM concentrations.

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2RM.1

Using Remote Sensing to Assess Uranium Dust Exposure from Abandoned Uranium Mines on the Central Region of the Navajo Nation. LEESHIYA JAMES, *Northern Arizona University*

Native American and Alaskan Native lands contain the majority (96%) of all uranium deposits in the United States. Since the 1980s, these mines have been abandoned, leaving behind toxic materials. Over 500 of these abandoned uranium mines (AUMs) are located on the Navajo reservation, home to the Dine(Navajo) people. The exposure of the uranium and heavy metals in the air poses a significant threat to the people who live in the areas in close proximity of these AUMs. Using wind pattern analysis and aerosol optical depth (AOD), we examined whether winds carry higher aerosol loads and analyzed dust resuspension patterns in Central Region of the Navajo Nation. In the future, we will use trajectory tools such as the Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model and aerosol optical depth (AOD), we will aim to identify potential accumulation areas with higher concentrations of heavy metal aerosols. This project could support public health efforts for other communities facing similar environmental risks.

2RM.2

Identifying the Causes of Air Pollution (Impossible Without Meteorology). VLADIMÍRA VOLNÁ, Daniel Hladký, *Czech Hydrometeorological Institute*

The poster illustrates how meteorological data can be used to identify the causes of air pollution in Central Europe.

Meteorological conditions influence the dispersion of pollutants in the air, resuspension, the formation of secondary particles, and they also affect the amount of emissions released from sources. Conversely, air quality fundamentally influences the entire climate system of our planet. Atmospheric pollution affects vegetation, ecosystems, and the climatic conditions.

Concentration and weighted concentration roses in various types of representations are routinely used to identify pollution sources. In cases where only daily concentrations of a given pollutant are available, a methodology "daily type of wind" is applied. To facilitate the identification of episodes with high concentrations of a specific substance, an internal “back trajectory of wind” application is used (along with cluster analysis). Long-range transport (e.g., Saharan dust) is visualized using the HYSPLIT model or, for example, CAMS European Air Quality Forecasts.

Wind roses, classified by stability and wind speed, are calculated using the CALMET meteorological model. These wind roses are one of the basic inputs for certain dispersion models (SYMOS, ATEM). Others include CAMx (using the ALADIN meteorological forecast model), GRAL (using meteorological parameters from the station network or calculated by a meteorological model), CALPUFF, AERMOD, and AUSTAL. Dispersion models focus on the transport of pollutants from a known source, the dilution of concentrations during transport, and the prediction of pollutant concentrations and chemical and physical processes in the air. Mathematical equations in dispersion models describe atmospheric physical and chemical processes and pollutant dispersion.

The smog warning and control system operated in the Czech Republic serves to provide information on situations involving elevated concentrations of air pollutants and to limit their emissions from sources. The rules for issuing warnings depend not only on exceeding concentration thresholds but also on the meteorological forecast.

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2RM.3

Light Absorption Characteristics of Brown Carbon over the Bay of Bengal. ASHISH SONI, Shivdas Bankar, Pawan S. Soyam, Thara Prabhakaran, Sudarsan Bera, Sachin Patade, Neelam Malap, P. Murugavel, Sunil Sonbawne, Craig M. Lee, *Indian Institute of Tropical Meteorology*

Atmospheric aerosols play a vital role in offsetting warming caused by greenhouse gases. However, the light-absorbing fractions of carbonaceous aerosols, such as Black Carbon (BC) and Brown Carbon (BrC), introduce significant uncertainties into climate models. A significant reason for this uncertainty is that the properties of carbonaceous aerosols are poorly defined by existing observations. This lack of clarity needs to be addressed to understand their true impact on climate and air quality. This study investigated the mass and absorption characteristics of various carbonaceous aerosol species using in-situ observations with a multi-wavelength Aethalometer during a cruise across the Bay of Bengal (BoB) transect from 2 °N to 18 °N in April-May 2024. The results showed increased BC mass at higher latitudes. Air mass back trajectory analysis indicated that the elevated BC levels in the northern latitudes were largely due to long-range transport of carbonaceous aerosols from the Indian subcontinent. Interestingly, the contribution of BrC was relatively large (17 %) at southern latitudes compared to the northern latitudes (10 %), where air masses originated from remote oceanic regions. Evidence showed a strong positive correlation between NO2 emissions and BrC absorption at lower (southern) latitudes, suggesting that NOx emissions from ship traffic along the Indo-Pacific trade route may enhance the production of nitrogen-containing BrC chromophores, which are more light-absorbing.

2RM.4

Shading the Sun, Brightening the Streets: Assessing the Relationship Between AOD, Surface Albedo, and LST Across Los Angeles, California. KATHERINE ALFORD, *Northern Arizona University*

Extreme heat is a major threat to Los Angeles, where urban development and the Urban Heat Island effect may create unequal thermal exposure across communities. Surface albedo can influence land surface temperature (LST), while atmospheric aerosol optical depth (AOD) affects incoming solar radiation and may modify surface–temperature relationships. However, these relationships may differ between high- and low-burden areas. This study aims to examine associations between satellite-derived AOD, surface albedo, and LST across ten Los Angeles stations from 2020–2026. Stations were classified as high-burden (urban/industrial) or low-burden (coastal/suburban). Landsat 8/9 LST, MODIS MCD43A3 albedo, and MODIS MAIAC AOD were matched by station and date. Raw measurements and quality-assurance information were extracted in Google Earth Engine, while missingness, physical plausibility, seasonal, and station-season outlier filters were applied in R. High-burden stations had a mean LST of 36.7°C compared with 30.3°C in low-burden stations, a difference of approximately 6.4°C. Mean AOD was nearly identical between groups, while mean albedo was slightly higher in high-burden areas. In all-season models, AOD was negatively associated with LST, and the positive AOD x albedo interaction indicated that this association became less negative as albedo increased. The interaction was significant in both burden groups. These findings highlight unequal thermal exposure across Los Angeles and the importance of considering atmospheric conditions and spatial inequities when evaluating surface-based heat-mitigation strategies.

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2RM.5

Updating Dry Deposition Parameterization with New Marine Flux Measurements. SARA NIELSON, Rutambhara Joshi, Roman Liedtke, Ricardo Pena, Delphine K. Farmer, *Colorado State University*

Aerosol direct and indirect effects are the leading source of uncertainty surrounding Earth's anthropogenic radiative forcing. Over Earth's oceans, these effects are amplified by increasing the albedo of the otherwise dark surface. The extent of these effects depends on the lifetime of aerosols, which depends on the removal rates by wet and dry deposition. While wet deposition dominates global aerosol removal, dry deposition remains an important global loss mechanism, which is poorly constrained over the ocean due to sparse measurements. Further, dry deposition rates of accumulation-mode aerosol are the largest source of uncertainty in aerosol indirect effects, especially over Earth's oceans. Here, we present new size-resolved accumulation-mode dry deposition rates calculated from eddy covariance flux observations collected over the Pacific Ocean from the Ellen Browning Scripps Memorial Pier in La Jolla, California (USA), from April to December 2024. The measurements were collected with a modified Portable Optical Particle Spectrometer and a sonic anemometer to calculate 30-minute-average fluxes throughout the campaign. Our new dry deposition measurements are 1-2 orders of magnitude larger than previous measurements and model predictions, suggesting the prior deposition rates over the ocean may be underpredicted. The discrepancy between widely-used models and our new measurements can be largely accounted for by incorporating a condensation growth factor and considering sea spray interactions near the surface.

2RM.6

A Theoretical Study on Transport and Deposition of Airborne Microplastics. MCKENZIE SWINDLE, Kelly Lazar, Andrew Metcalf, *Clemson University*

Microplastics have come to be recognized as a ubiquitous environmental contaminant. Their presence in remote areas indicates long-range transport and deposition, and the nature of that transport and deposition has been explored through a variety of case studies in recent literature. Few studies, however, have examined the atmospheric transport and deposition of microplastics from a theoretical perspective. Little is understood about the exact mechanisms underpinning their displacement, particularly under specific weather conditions. This study is a first step toward developing a foundational theoretical framework for evaluation of microplastic particle behavior during transport and deposition under a range of weather conditions, as well as degradation of these particles throughout transport. The primary focus of the current study is how deposition patterns may be influenced by particle size, shape, and density and atmospheric conditions such as stability and wind speeds. This topic is explored via calculations of settling velocity and dispersion modeling of microplastic particles previously measured in the environment. Terminal settling velocities are determined using Stokes' law for a range of particle characteristics, and EPA atmospheric dispersion model AERMOD is used to evaluate transport behavior under specific atmospheric conditions. Preliminary calculations indicate that smaller microplastic particles may remain suspended for longer periods of time, allowing for longer-range transport. Increased deposition rates are often seen as a result of increased precipitation and larger particles, whereas increased radius of transport is often tied to stronger winds. This work will contribute to an improved, more generalized theoretical understanding of the atmospheric microplastic transport process that will elevate our understanding beyond the limits of regional observations. Improved characterization of transport behavior is crucial to our growing knowledge of atmospheric microplastic transport pathways and to our ability to monitor and predict risks associated with airborne microplastics.

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2RM.7

Spatial Analysis and Source-Investigation of Aerosols in a Legacy Anthracite Coal Region (Shamokin, PA). Douglas Collins, Shaunna Barnhart, Brian King, Sean Koranteng, Iniyan Lourderaj, Calvin McGuire, Zoey Spang, Samuel Tuffour, DABRINA DUTCHER, *Bucknell University*

The Lower Anthracite Coal Region of Pennsylvania contains widespread legacy coal waste, active mining, and a dearth of nearby regulatory air-monitoring sites, creating uncertainty about present-day particulate exposures in and around Shamokin, PA. Shamokin is a compelling environmental-health study region because it sits within a legacy anthracite coal landscape where persistent socioeconomic disadvantage, elevated mortality, and high cancer burden overlap spatially with coal waste deposits and active extraction. We have deployed a distributed air quality monitoring network to resolve spatial gradients and source-influenced temporal patterns in a geographically constrained coal-region community. The network combines centralized, intensive measurements at a hub site with neighborhood-scale sensor nodes spreading across the region. The network includes reference-collocated optical particle counters for PM1, PM2.5, and PM10 (QuantAQ); gas-phase measurements of CO, O3, NO, and NO2 (QuantAQ); black carbon aethalometers (AethLabs MA200); meteorological observations; PAH sampling; and a 4-DRUM sampler for size-resolved, time-resolved aerosol collection. Lower-cost PurpleAir PM2.5 sensors will provide even broader spatial coverage (and citizen science engagement). Spatial analysis will compare pollutant distributions across site types representing basin, near-source, residential, and regional-background conditions, with emphasis on concentration gradients, episodic enhancements, and wind-sector dependence. Source apportionment will be approached through integrated indicators rather than a single receptor model: co-variation among PM size fractions, black carbon, CO/NOx, wind direction, time-resolved particle properties, and size-resolved aerosol composition will be used to distinguish likely contributions from coal dust resuspension, combustion-related particles, regional transport, and local activity. PAH measurements at the main site will provide chemical context for coal-related semivolatile organic compounds, while recognizing that single-site speciation cannot fully represent spatial gradients. This work demonstrates a community-engaged monitoring strategy for rural or small-city areas where conventional regulatory networks may miss sharp local or regional gradients. The resulting dataset will support public-facing interpretation of air quality, guide targeted future sampling, and provide an analytic framework for linking legacy extraction landscapes with contemporary aerosol exposure patterns.

2RM.8

Comparing Gems Aerosol Optical Properties with DC 8 in Situ Measurements Across the Asia AQ Domain. SAYANTEE ROY, Francesca Gallo, Elizabeth Wiggins, Luke Ziemba, Carolyn Jordan, Edward Winstead, Michael Shook, Richard Moore, *NASA Langley Research Center*

NASA's 2024 Airborne and Satellite Investigation of Asian Air Quality (ASIA-AQ) campaign provided coordinated aircraft and satellite observations across the Philippines, South Korea, Thailand, and Taiwan during the peak dry-season pollution period. Biomass-burning smoke and urban emissions strongly influence aerosol loading in these regions, motivating the need to evaluate aerosol optical properties using complementary datasets. In this study, we compare aerosol single scattering albedo (SSA) and aerosol optical depth (AOD) from the Geostationary Environment Monitoring Spectrometer (GEMS) with in situ measurements collected by the Langley Aerosol Research Group (LARGE) aboard the NASA DC-8. GEMS AOD captures regional pollution gradients, while aircraft observations reveal pronounced vertical and horizontal variability in SSA associated with mixed smoke–urban layers and boundary-layer dynamics. The combined aircraft–satellite perspective highlights how regional emissions, terrain, and meteorology shape aerosol optical properties across the ASIA-AQ domain. These results improve interpretation of geostationary aerosol retrievals and support ongoing efforts to assess air-quality impacts and pollution transport in Southeast Asia.

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2RM.9

The University of Wisconsin-Madison Space Science and Engineering Center Portable Atmospheric Research Center (SPARC). MIGUEL HILARIO, Mónica B. Pabón Hernández, Jonathan Gero, Edwin Eloranta, Robert Holz, Zachary Buckholtz, Timothy Wagner, Erik Olson, Mark Mulligan, *University of Wisconsin-Madison*

Obtaining and deploying specialized field instrumentation can be a major obstacle for individual principal investigators. As part of the National Science Foundation's (NSF) Community Instruments and Facilities (CIF) program, the University of Wisconsin-Madison (UW) Space Science and Engineering Center (SSEC) Portable Atmospheric Research Center (SPARC) provides the community with a mobile research laboratory equipped with a combination of remote sensing profiling and in situ instruments that simultaneously measure properties of aerosols, radiation, moisture, clouds, and wind in the troposphere. The SPARC can be requested from NSF for deployment to regions of interest to address a wide range of science objectives. Remote sensing profilers include a High Spectral Resolution Lidar (HSRL), an Atmospheric Emitted Radiance Interferometer (AERI), and a doppler wind lidar. The SPARC recently expanded its capabilities with a Micro-Orifice Uniform Deposit Impactor (MOUDI), which measures in situ size-resolved aerosol composition. These instruments are complemented by radiosondes and surface weather observations. The SPARC can enhance field experiments and synergize with other atmospheric instrumentation. This presentation showcases results from previous SPARC collaborations and a case study in Madison, WI to demonstrate synergy between the SPARC's MOUDI and remote sensors. With its suite of meteorological, optical, and chemical measurements, the SPARC is well-equipped to meet community needs to make state-of-the-art measurements of the planetary boundary layer, clouds, aerosols, and their combined effects on local to regional air quality.

2RM.10

A Data-Driven Airshed Framework with High-Resolution Downscaling for Improved PM2.5 Estimation. MOHAMMAD ZAID, Manoranjan Sahu, *Indian Institute of Technology Bombay*

Air pollution remains a major global challenge, particularly in India, where $PM_{2.5}$ poses serious health risks. Its complex spatial variability driven by meteorology, topography, and emissions, along with sparse monitoring networks, limits effective air quality management. This study develops a machine learning-based framework for airshed regionalization and high-resolution $PM_{2.5}$ downscaling to support air quality management in India. Spatially continuous $PM_{2.5}$ concentrations for 2020-2022 were first estimated at ~55 km resolution by integrating reanalysis data from MERRA-2, including aerosol components (BC, OC, SO_4, dust, and sea salt) and meteorological variables, achieving R^2 = 0.71 and RMSE = 27.58 μg/m^3. Multiple clustering algorithms applied to modeled $PM_{2.5}$, meteorology, and land-use data for each year, delineated seven major airsheds across India. The results were statistically validated and showed temporal stability, demonstrating robustness for long-term policy applications and improved identification of dominant pollution sources. Building on this, $PM_{2.5}$ estimation was extended to 1 km resolution using a hybrid downscaling framework for two highly polluted airsheds, the Indo-Gangetic Plain and arid regions. Instead of directly downscaling $PM_{2.5}$ using proxy variables, MERRA-2 aerosol components were first downscaled to preserve underlying physical and chemical processes. Multi-source datasets including satellite-derived gap-filled MAIAC AOD, IMDAA reanalysis meteorology, VIIRS fire counts, population density, road networks, and land surface characteristics were integrated following spatial and temporal harmonization. The downscaled aerosol models demonstrated strong performance, (R^2 = 0.87 - 0.91; RMSE = 0.56 - 7.81 μg/m^3). Finally, these high-resolution aerosol estimates, combined with land characteristics and ground observations, within a Random Forest framework to generate high-resolution daily $PM_{2.5}$ estimates across ~544 million data points, achieving improved accuracy (R^2 = 0.84, RMSE = 20.36 μg/m^3) compared to the coarse-resolution model. Overall, this study establishes a scalable and physically consistent framework for high-resolution $PM_{2.5}$ mapping and supports region-specific air quality management in data-sparse environments.

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2RM.11

Spatializing Long-Term Multi-Site Particle Size Distribution Measurements with Satellite Data for Gridded Particle Number Exposure and Mortality Estimation in Taiwan. CHIH-YU CHAN, Jun-Fa Ye, Jian-Xian Wu, Shi-Ya Tang, Li-Hao Young, Tse-Lun Chen, Si-Chee Tsay, Ta-Chih Hsiao, *National Taiwan University, Taiwan*

The health hazards of airborne particulate matter are not solely determined by mass concentration ($PM_{2.5}$); particle number concentration (PNC)—particularly that of ultrafine particles (UFP, <100 nm)—poses health risks independent of mass, owing to their ability to penetrate deep into the alveoli and translocate across biological barriers. However, current attributable mortality assessments are predominantly based on satellite-retrieved $PM_{2.5}$ mass, lacking a spatially explicit quantification framework centered on particle number concentration. This study integrates long-term SMPS and APS measurements collected by multiple representative sites in Taiwan—covering urban, industrial, and rural —to reconstruct the complete climatological size distribution from 10 nm to 20 μm and to extract number concentration characteristics of the nucleation, accumulation, and coarse modes. Multivariate statistical and machine learning methods are then employed to fuse Sentinel-5P TROPOMI, MODIS AOD, and ERA5 reanalysis data, upscaling multi-site PNC into high-resolution gridded fields covering all of Taiwan. Given the substantial uncertainty in UFP exposure–response functions, this study adopts a multi-scenario approach, establishing low, medium, and high relative risk coefficients to stratify the assessment of all-cause, cardiovascular, and respiratory mortality, with the resulting range reported as a confidence interval for population-weighted exposure and attributable deaths. Finally, three PNC reduction scenarios (10%, 25%, and 50%) are designed to quantify the number of premature deaths avoidable in Taiwan, providing an uncertainty-quantified policy basis for incorporating ultrafine particles into air quality management.

2RM.12

Simulations of Secondary Organic Aerosol Formation Using CMAQ-UNIPAR During the 2024 ASIA-AQ Campaign. GANGHAN KIM, Myoseon Jang, *University of Florida*

The UNIfied Partitioning-Aerosol phase Reaction (UNIPAR) model predicts secondary organic aerosol (SOA) formation via multiphase partitioning and aerosol-phase reactions of explicitly predicted products from the oxidation of various precursors. This UNIPAR was integrated into the Community Multiscale Air Quality Modeling System (CMAQ) to predict SOA mass and species across the Korean Peninsula during the Asia Air Quality (ASIA-AQ) campaign in 2024. CMAQ-UNIPAR included 10 aromatics, alkanes with different carbon lengths and branching ratios, naphthalene, isoprene, terpene, and sesquiterpene. Simulations indicated that nearly 35% of the organic aerosol mass in wintertime Seoul was associated with SOA, and almost all of the SOA was anthropogenic. Alkane SOA was the most prominent (25%), followed by aromatic SOA (8%). In wintertime, biogenic emissions are suppressed due to reduced biogenic activity, resulting in almost no terpene- or isoprene-derived SOA formation in South Korea. Compared with the summer case in the Korea-United States Air Quality (KORUS-AQ) campaign, the reductions in terpene and isoprene SOA are about 14-15%. Most of the anthropogenic SOA is concentrated in the West Sea and the western coastal region, which appears to be affected by transport from China or the Manchu region. In Seoul, where the NOx is rich, the simulated terpene SOA increased with increasing NOx levels, but the anthropogenic SOA formation declined slightly. A diurnal pattern appeared for terpene SOA, showing relatively high SOA formation at nighttime owing to the terpene reaction with nitrate radicals to form low-volatile organonitrates. The reduced nighttime mixing height limited precursor and radical concentrations at high altitudes, thereby suppressing biogenic SOA formation. Anthropogenic SOA was produced mainly in the daytime when OH radicals were abundant, but also showed a slow reduction at night, which is why anthropogenic SOA persists long in the atmosphere.

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2RM.13

Modeling Atmospheric PFAS Fate and Transport from Waste and Industrial Sources Across Ohio. DEEPSHIKHA OLA, Andrew A. May, *The Ohio State University*

Per- and polyfluoroalkyl substances (PFAS) are persistent environmental contaminants with significant risks to human health and ecosystems. While much research has focused on PFAS contamination of water, growing evidence suggests that atmospheric transport and deposition also contribute to their redistribution. Waste management facilities, including landfills, waste incinerators, and wastewater treatment plants, as well as other industrial sources, are significant emitters of airborne PFAS. However, the magnitude and spatial distribution of these emissions and their relative contributions to regional PFAS loading, including the influence of local sources, remain poorly understood, limiting our ability to assess exposure pathways and develop effective mitigation strategies.

To address this gap, our study will develop a PFAS emissions inventory for various industrial and waste management sectors across Ohio and use this inventory to model their atmospheric fate and transport. We will compile available PFAS emission factors from the literature and assign them to known facility locations to represent potential source strengths. These emissions will be used to configure and run the CMAQ-PFAS model, which incorporates PFAS-specific atmospheric processes, including gas-phase partitioning, chemical behaviour, and wet and dry deposition. Model simulations will be used to characterize the spatial patterns of PFAS deposition and to evaluate how different source categories influence regional PFAS loading. The expected outcomes of this work would include the first detailed PFAS emission inventory for Ohio's waste and industrial sectors, statewide maps of PFAS atmospheric deposition, and estimates of the contributions of each source type to PFAS loading.

These results will improve understanding of PFAS fate and transport and help guide future monitoring, risk assessment, and policy decisions. By characterizing the spatial distribution of atmospheric PFAS deposition, this study will help identify the locations where mitigation or remediation efforts may be needed, providing a clearer picture of PFAS movement through the air.

2RM.14

Characteristics of New Particle Formation over the Arctic Ocean by Shipborne Measurements. Kihong Park, HYUNGJIN CHO, Haebum Lee, Jiyeon Park, Young Jun Yoon, *Gwangju Institute of Science and Technology*

Shipborne observations over the Arctic Ocean allow for the direct sampling of pristine air masses and the capture of rapid environmental changes over various seas to address how freeze-up dynamics (open water, marginal ice, and pack ice) and localized emission influence new particle formation (NPF) and aerosol population. The shipborne measurements were conducted during the cruise of the Korean ice-breaker (ARAON), including particle size distributions (3–600 nm), total particle number concentrations, PM2.5, black carbon (BC), aerosol optical depth (AOD), and cloud condensation nuclei (CCN) in the September (the minimum sea ice in the Arctic) and October of 2023, and in the July-September of 2025. By relating the atmospheric aerosol data to sea ice dynamics, seawater properties, and meteorological factors, we investigate the drivers of NPF across diverse marine environments (Chukchi sea, Arctic ocean, East Siberian sea, Being sea, and Pacific Ocean). This work also examines how the sea ice retreat/advance modulate new particle formation in the warming Arctic. A distinct shift in the aerosol size distribution from an Aitken mode-dominant regime over the Arctic ocean to an accumulation mode-dominant regime over the Pacific Ocean was observed. The NPF frequency and intensity were the stronger over the Arctic Ocean than the Pacific Ocean, due to the higher emission of marine biogenic emissions. The number concentration of nanoparticles (N(3-25 nm)) was the highest during the cruise over the East Siberian Sea where the sea ice extent and sea surface salinity were the lower that those over the Arctic Ocean.

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2RM.15

Single-Particle Characterization of Aerosol Physicochemical Mixing State in the Southeastern United States. HOLLY LAWSON, Xu He, Rachel O'Brien, Andrew P. Ault, *University of Michigan*

The climate and air quality impacts of atmospheric aerosol particles are strongly governed by their individual physicochemical properties, including size, chemical composition, and morphology. Aerosol physicochemical mixing state describes the distribution of these properties across a particle population and is influenced by the proximity of particle emission sources and chemical evolution (i.e., aging) in the atmosphere. Although particle-to-particle heterogeneity is fundamentally driven by regional emission sources, the physicochemical mixing state between biogenic-anthropogenic interfaces remains poorly constrained. The U.S. Department of Energy Atmospheric Radiation Measurement (ARM) Mobile Facility 3 (AMF3), located in William B. Bankhead National Forest, provides a unique biogenic-dominated reference point within the Southeastern United States for the ability to observe how natural emissions transform with anthropogenic pollution. In this study, continuous online measurements including aerosol size distributions, cloud condensation nuclei concentrations, and meteorological data are combined with offline single-particle microspectroscopic analysis to characterize aerosol physicochemical mixing state. Size-resolved samples were collected onto alphanumerically gridded substrates in both summer 2025 and spring 2026 at AMF3 to enable particle colocation across techniques. Particle samples were characterized using a complementary suite of single-particle analysis techniques, including optical-photothermal infrared (O-PTIR) spectroscopy, Raman microspectroscopy, and computer-controlled scanning electron microscopy with energy dispersive X-ray (CC-SEM-EDX) spectroscopy. Preliminary observations reveal heterogeneity among particles within the same air mass, as well as seasonal variations in chemical composition that reflect changes in emission sources, atmospheric processing, and meteorological conditions. This work contributes to a more complete understanding of aerosol complexity in the southeast U.S., with important implications for aerosol-cloud interactions, air quality, and climate model representations of aerosol processes occurring in this region.

2RM.16

Characterizing Organic Aerosols in Barbados Using Optical Photothermal Infrared and Raman Spectroscopy. CAROLINE LEE, Rebecca L. Parham, Kayleigh Reilly, Sujan Shrestha, Phoebe Scharle, Randi Libin-Straub, Cassandra Gaston, Andrew P. Ault, *University of Michigan*

The Saharan air layer (SAL) is an air mass that transports atmospheric particles across the Atlantic Ocean from the Saharan region of the African continent to North America, South America, and the Caribbean Sea. These trans-Atlantic aerosols include dust, biological material, smoke, and sulfate-containing particles, and they can mix with each other during atmospheric transport. The particles can further mix with local emissions, such as sea spray aerosol (SSA), while descending through the marine atmospheric boundary layer (MABL). These interactions between particles can impact regional climate near Barbados due to changes in particle properties, such as optical properties and hygroscopicity, when particles are mixed.

Previous single-particle analysis of aerosol populations using scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDX) has provided information on the heterogeneity of particles, which is important when assessing mixing state. However, further research is needed to characterize the physical and chemical properties of organic particles near Barbados. Herein, we characterize the mixing state of summertime and wintertime aerosol samples collected at Ragged Point, Barbados via simultaneous optical photothermal infrared and Raman (O-PTIR+Raman) spectroscopy. This location allowed samples to be collected before mixing with local anthropogenic emissions. Summertime and wintertime particle samples were evaluated with O-PTIR+Raman spectroscopy, which combines vibrational information from IR and Raman spectroscopy for molecular characterization of individual particles. Aerosol mixing state was evaluated by clustering the PTIR spectra to determine common chemical particle types. These results were additionally compared with the elemental information provided by SEM-EDX. Together, these techniques provided information on the molecular and elemental compositions of individual aerosol particles. Comprehensive single-particle characterization of these particles will improve our understanding of mixing state in the SAL and their potential impacts on local climate in Barbados.

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2RM.17

Ambient Gas-Phase Water-Soluble Organic Carbon in the High Desert of Joshua Tree National Park. BRYNNA SELIGMAN, Madison Landi, Sergey Nizkorodov, Annmarie Carlton, *University of California, Irvine*

Water-soluble organic gases ($WSOC_g$) in the atmosphere can partition to liquid water and contribute to deposition and aqueous secondary organic aerosol (aqSOA). Yet, their abundance and variability in arid receptor environments remain poorly characterized. We report quasi-continuous measurements of gas-phase water-soluble organic carbon ($WSOC_g$) at Joshua Tree National Park, California, during 15–30 June 2026. $WSOC_g$ was collected using mist chamber sampling and quantified by total organic carbon analysis at a time resolution of 15 minutes. Joshua Tree is an arid receptor frequently influenced by emissions transported from the South Coast Air Basin, providing an opportunity to examine whether water-soluble organic gases remain abundant following regional transport.

$WSOC_g$ concentrations averaged 11.1 µg C m^{-3}, with a median of 12.5 µg C m^{-3} and an interquartile range of 8.72 - 13.0 µg C m^{-3}. These concentrations are higher than the concentrations found in recent campaigns across southern California including: Pasadena (mean = 6.69 µg C m^{-3}) and Irvine (mean = 2.91 µg C m^{-3}). $WSOC_g$ exhibited a reproducible diel cycle, with concentrations highest near 16:00 local time and lowest near 06:00. Concentrations were enhanced during southwesterly flow from the Los Angeles Basin and were associated with ozone and wind speed, consistent with regional transport and photochemical production. $WSOC_g$ also increased with relative humidity (dCor = 0.78), although covariance among humidity, transport, and time of day hinders specific attribution to humidity alone.

These measurements demonstrate that an arid downwind receptor can contain a substantial reservoir of water-soluble organic gases. The observed abundance and afternoon enhancement suggest that oxidized organic gases formed during regional transport may remain available for multiphase processing far from their source regions, even in desert environments.

2TA.1

Photochemical Aging of Dark Brown Carbon Aerosols: Changes in Light Absorption and Cloud Activation. SHU-WEN YOU, Taveen S. Kapoor, Prabhav Upadhyay, Li-Ti Chou, Zezhen Cheng, Alla Zelenyuk, Amna Ijaz, Gregory W. Vandergrift, Gourihar Kulkarni, Sining Niu, Ta-Chih Hsiao, Swarup China, Rajan K. Chakrabarty, *Washington University in St. Louis*

Dark brown carbon, a distinct subtype of light-absorbing organic aerosols, is strongly absorbing across near-ultraviolet, visible, and near-infrared wavelengths, insoluble, and has been shown to retain absorptivity following photochemical aging, prompting a re-evaluation of the role of organic aerosols in climate models. In addition, the aerosol-cloud interaction of dark brown carbon remains unexplored. Here, we investigate the effects of prolonged photochemical aging of synthetic wildfire-like dark brown carbon aerosols and show that their intrinsic light absorption remains stable over aging timescales of up to 11.5 atmospheric days. We further demonstrate that photochemical aging can modify the absorption and enhance the hygroscopicity of dark brown carbon, potentially through secondary organic aerosol coating and direct surface oxidation. The observed changes in dark brown carbon's light absorption and hygroscopic properties may be explained by size-dependent chemical composition, with smaller aerosols tending to be more refractory and thus more inert, while larger aerosols, containing higher fractions of polyaromatic hydrocarbons, exhibit greater reactivity toward OH radicals. Lastly, we show that freshly emitted dark brown carbon exhibits ice-nucleating activity comparable to that of black carbon at cirrus-relevant temperatures, indicating that it is an inefficient ice-nucleating particle. Together, these results suggest that photochemical aging decouples the optical persistence and water uptake of dark brown carbon, with potential implications for its ice-nucleating properties. Incorporating these properties into climate models may reduce uncertainties in estimates of the direct and indirect radiative effects of biomass burning organic aerosols.

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2TA.2

Physicochemical and Toxicological Effects of Size-Selected Soot as a Function of Atmospheric Aging. YASH DHANSARE, Shubham Sunil Sharma, Shu-Wen You, Joseph V. Puthussery, Benjamin Kumfer, Rajan K. Chakrabarty, *Washington University in St. Louis*

Atmospheric aging changes the physicochemical nature of soot particles, which may potentially enhance their light absorption and cellular oxidative reactivity. However, aging may transform soot particles differently across different particle sizes. Previous studies have compared fresh and aged soot, but the investigation of size-segregated soot particles after aging, across sizes, remains unexplored.

In this study, we investigated the size-resolved evolution of ethylene-flame soot after simulated atmospheric aging, focusing on changes in physicochemical, optical, and toxicological properties. Individual particle mass, single-particle refractory black carbon mass and absorption coefficients were measured using CPMA, SP2, and TAP instruments, respectively. Particles collected on quartz filters were used for elemental-organic carbon (EC-OC) analysis and oxidative potential assessment using the OP-DTT assay. Fresh soot particles were size-selected using DMA and injected into PAM-OFR (equivalent aging ~5 days, RH = 55%) to produce aged-polydisperse aerosols. Five different sizes were chosen: 70, 90, 160, 230, and 300 nm.

Aging shifted the particle size distribution toward larger diameters while preserving the overall distribution shape, suggesting particle growth driven by condensation and coagulation. Aging increased the OC/EC ratio across all size fractions, suggesting organic enrichment. The mass-mobility exponent of 2.14 confirmed the fractal, aggregated structure of the soot. Optical analysis indicated an increase in AAE values after aging for ultrafine particles, indicating the addition of brown-carbon-like material. Toxicological analysis showed that aging suppressed the mass-normalized DTT activity for ultrafine particles but it slightly increased for larger particles. This study highlights that aging does not affect soot particles uniformly across sizes but instead produces size-dependent changes.

2TA.3

Turbulence, Droplet Activation, and Aqueous IEPOX-SOA Chemistry: Millimeter-to-Cloud-Scale Insights from the MTU Pi Chamber. MANISHKUMAR SHRIVASTAVA, Andreas Zuend, John Shilling, Steven Krueger, Yuzhi Chen, Alla Zelenyuk, Richard Flagan, Anthony S. Wexler, Raymond Shaw, Will Cantrell, Jie Zhang, Mikhail Ovchinnikov, Gourihar Kulkarni, Mikhail Pekour, Hamed Sadi, Jesse Anderson, Jaemin Yeom, Jason Surratt, Avram Gold, Suryadev Singh, James Simmons, *Pacific Northwest National Laboratory*

Isoprene is the most abundant non-methane volatile organic compound emitted by vegetation globally, yet the impact of IEPOX on cloud droplets under active supersaturation has not been studied in laboratory cloud chambers, due to challenges forming and sustaining droplets on the timescale of several minutes needed for aqueous IEPOX chemistry. The MTU Pi cloud chamber simulates cloud microphysical processes under sustained turbulence and supersaturation, enabling probing of IEPOX chemistry within aerosol and cloud droplet phases. Here we apply the Explicit Mixing Parcel Model with multiphase chemistry (EMPM-Chem) to reproduce the MTU chamber and link millimeter-scale supersaturation fluctuations to droplet activation and in-cloud IEPOX-SOA formation.

The MTU Pi chamber sustains supersaturation fluctuations to centimeter-to-millimeter scales; EMPM-Chem resolves scales to the Kolmogorov length (~1 mm), enabling a one-to-one mapping between simulated and measured evolution. The model tracks droplets and haze particles through repeated activation–evaporation cycles, resolving soluble-gas co-condensation on timescales of seconds and IEPOX-SOA formation kinetics of less than 5 minutes, far too fast for Earth system model timesteps (~30 minutes) to capture. Model parameters are grounded through AIOMFAC thermodynamic calculations, constraining hygroscopicity (kappa) and surface tension depression, and accounting for nonideal mixing, liquid–liquid phase separation, and organic surface enrichment.

We simulate two forcing regimes (chamber bottom to top plate temperature difference = 8 K and 16 K) representing low and high supersaturation, analogous to shallow and deeper cloud environments. Low supersaturation limits droplet growth, producing smaller, longer-lived droplets with extended reaction times and higher solute concentrations, conditions most favorable for IEPOX-SOA formation, wherein lower droplet pH accelerates IEPOX kinetics. Model evaluation spans observations encompassing activated and unactivated size distributions, composition, and droplet growth and decay kinetics. This framework, iteratively refined with MTU Pi chamber experiments, provides a mechanistic basis for understanding how co-condensation, aqueous-phase chemistry, and droplet activation interact on scales unresolved by Earth system models, pointing toward closures needed to reduce biases in simulated cloud formation.

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2TA.4

Single-Particle Measurements of Optical Properties in Aqueous Brown Carbon Systems. PRAKRITI SINGH, Erin Bowey, Malsha Amugoda, Pedro De Allende, James F. Davies, Paula K. Hudson, *University of California, Riverside*

Aqueous-phase brown carbon (BrC) forms through carbonyl–amine chemistry and evolves under atmospheric humidity conditions, but its RH-dependent optical aging remains poorly understood. We investigate the influence of RH on the visible absorbance of both freshly prepared and aged (up to 23 days) methylglyoxal–glycine droplets levitated in an electrodynamic balance (EDB). Even in droplets aged for up to three weeks in aqueous solution, absorbance measured in a levitated droplet continues to increase, indicating ongoing chemistry leading to further browning. Droplets aged at high RH (~95%) show minimal absorbance, while those exposed to intermediate RH (~55%) show significantly stronger absorption in the visible range. However, at lower RHs (25 to 15%), the absorbance is low despite the high solute concentration, indicating that chromophore formation is most efficient at intermediate RH. Droplets dried and subsequently rehydrated show higher absorbance than at the same RH prior to drying, with the effect most pronounced for high-RH samples, possibly due to enhanced BrC formation during transitions through intermediate RH regimes (~50%). To extend this work, we plan to perform photolysis experiments on levitated droplets under UVA and UVB illumination leveraging an open-port sampling interface coupled with an Orbitrap mass spectrometer so determine the changes in chemical composition.

2TA.5

Chemical Aging of Methylglyoxal-Glycine Aqueous Brown Carbon Aerosol as a Function of RH. ERIN BOWEY, Prakriti Singh, Malsha Amugoda, Pedro De Allende, Paula K. Hudson, James F. Davies, *University of California, Riverside*

Methylglyoxal (MeGX) is among the most abundant α-dicarbonyl compounds in the atmosphere, having both biogenic and anthropogenic sources. Its high solubility in water leads it to partition into cloud droplets where it can hydrate into diol or gem-diol forms. Other highly water-soluble and nitrogen-containing species such as the amino acid Glycine (Gly) have been shown to react with MeGX, generating a variety of aqueous brown carbon (aqBrC) products such as imidazole and pyrrole compounds. The changing chemical composition of the droplet as it ages has a dynamic relationship with its physical properties, and is affected by the environmental relative humidity (RH). Aging will thus have consequences for participation in cloud formation, interaction with light, and ongoing chemistry. In this work, we produce aqBrC from the reaction of equimolar MeGX and Gly in bulk solution to mimic watery cloud droplets and levitate single particles with an electrodynamic balance (EDB) at controlled RH conditions. We measured chemical composition with electrospray ionization with orbitrap mass spectrometry equipped with an open-port sampling interface (OPSI-ESI-MS). Bulk solutions were aged over several weeks and sampled periodically. Particles were prepared from fresh solution by a piezoelectric dispenser, injecting a stack of particles to be trapped in the EDB at one of three RH values (90, 50, or 10%). Particles were individually introduced into the OPSI over time to explore an aging period of up to 2.5 hours. We observed that in all levitated particles, aging happened rapidly compared to the bulk with immediate observation of a methylimidazole product and an “end-stage” dimethylimidazole product. The RH at 50% displayed the fastest end-stage product formation, which we suggest is due to greater concentration of reactants compared to the more dilute 90%, but with enough liquid water present to solubilize reactants and avoid diffusion limitations at low RH.

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2TA.7

Photochemical Aging of Biomass Burning Organic Aerosols: Phase-Dependent Evolution of Optical Properties. AARON HARRISON, *Trinity University*

Biomass burning organic aerosols (BBOA) are a major component of atmospheric particulate matter with significant impacts on radiative forcing and air quality, yet the evolution of their optical properties during atmospheric aging remains uncertain. In particular, the extent to which the condensed-phase environment modulates the photochemical transformation of BBOA chromophores is not well understood. We present a multi-technique spectroscopic investigation of how BBOA optical properties evolve under simulated photochemical aging in different phase states.

Primary BBOA samples are generated from smoldering biomass and collected on filters. To probe the role of the condensed-phase environment, samples are aged under simulated solar irradiation both as filter-deposited particles and dissolved in solution. This comparison isolates the influence of the particle microenvironment where molecular mobility is restricted and reactants are concentrated from the dilute, freely-diffusing solution phase. The optical evolution is tracked using three complementary techniques: UV-Vis absorption spectroscopy to monitor changes in the overall light-absorption in the actinic UV, excitation-emission matrix (EEM) fluorescence spectroscopy to resolve the evolution of individual fluorescent components as well as time-resolved fluorescence spectroscopy.

2TA.8

Atmospheric Evolution of Organic Aerosol During Long Range Transport of Wildfire Plumes in North America. UMA PUTTU, Sumit Gupta, Shengqian Zhou, Jian Wang, Lu Xu, *Washington University in St. Louis*

Organic aerosol (OA) from biomass burning is a major component of atmospheric particulate matter, with important implications for air quality, human health, and climate. During long-range transport of wildfire plumes, normalized excess mixing ratio of OA to CO (ΔOA/ΔCO) decreases due to heterogeneous oxidation, dilution, and evolving secondary organic aerosol (SOA) formation. However, OA aging remains poorly constrained, due to limited characterization of in-plume chemistry, oxidant levels, and dilution rates. Although decreases in ΔOA/ΔCO have been reported, inferred rates may be biased by variability in ΔOA/ΔCO emitted, as well as differences in fire size, fuel composition, and background conditions, complicating the interpretation of downwind observations.

We find that variability in ΔOA/ΔCO emitted is largely driven by plume characteristics. For example, Chen et al. (2025) show that fuel type influences emission ratios of key tracers (CH_3CN, HCN, benzene, and toluene). Building on this, we use Fuel2Fire data from the FIREX-AQ campaign to characterize variability in OA/CO emission ratios, accounting for fuel type (based on the Fuel Characteristic Classification System) and contributions from flaming and smoldering combustion. We then investigate OA evolution by integrating the data from four aircraft campaigns (FIREX, SEC4RS, WECAN, BORTAS, and AEROMMA) and long-term fixed-site observations from the ENA site in the Azores, spanning diverse temporal and spatial scales across North America and its downwind regions. We then compare our results with a regional chemical transport model study by Pye et al. (2026), which parameterizes OA evolution using the Community Regional Atmospheric Chemistry Multiphase Mechanism (CRACMM3). This comparison reveals discrepancies that may reflect uncertainties in the emission ratios associated with the burned fuel type.

References:
[1] Chen, J.-H. et al. (2025), Environmental Science & Technology, 59(32), pp. 17145–17159.
[2] Pye, H.O.T. et al. (2026), Environmental Science & Technology Letters, 13(2), pp. 268–274.

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2TA.9

Molecular Composition and Optical Properties of Biomass-Burning Water-Soluble-Organic-Carbon. HANNAH FOLARIN, Diego Calderon-Arrieta, Jessica Knull, Sydney Spees, Julius Ese, Alexander Laskin, *Purdue University*

Water-soluble organic compounds (WSOC) comprise a major fraction of biomass-burning organic aerosol and contribute to brown carbon light absorption, yet their molecular composition and evolution during physicochemical processing remain incompletely understood. In this study, commercial liquid smoke was used as a chemically relevant surrogate for biomass-burning emissions to investigate WSOC composition, chromophore identity, and evaporation-driven changes in optical behavior.

Samples were analyzed by high-performance liquid chromatography coupled with photodiode array detection and high-resolution mass spectrometry (HPLC-PDA-HRMS). Wavelength-dependent absorbance measurements were used to derive mass absorption coefficients and absorption Ångström exponents over 300–432 nm. Molecular formulas were assigned from accurate mass measurements and interpreted using elemental class distributions and double bond equivalence.

The WSOC mixture was dominated by oxygenated CHO species, with additional CHON compounds and aromatic, conjugated structures consistent with substituted phenolic and lignin-derived chromophores contributing to near-UV light absorption. Controlled evaporation increased absorbance and spectral steepness while preserving the overall spectral profile, indicating preferential loss of more volatile, weakly absorbing constituents and enrichment of less volatile, strongly absorbing chromophores.

These results demonstrate that commercial liquid smoke serves as a reproducible surrogate for biomass burning WSOC and provides a controlled platform to investigate relationships among molecular composition, volatility, and light-absorbing properties under conditions relevant to aerosol processing and aging.

2TA.11

Investigating the Role of Aerosol Acidity in the Heterogeneous Oxidation of Organic-Inorganic Aqueous Particles. SHAIMA THADIYAMPURATH, Haofei Zhang, *University of California, Riverside*

Oxidation of organic aerosols by hydroxyl radicals in the atmosphere can transform the particle composition and its properties. By altering the hygroscopicity of organic aerosols, their ability to form cloud condensation nuclei may change. Furthermore, the presence of inorganic aerosols can change the pH of aqueous particles. However, the effects of acidity on aqueous organic aerosol particles' oxidation kinetics, products, and mechanisms remain largely unexplored. To investigate the effect of acidity in organic aerosol oxidation, we use glutaric acid as the model organic aerosol internally mixed with several different inorganic aerosol surrogates at a 1:1 mass ratio. We performed multiphase oxidation in a flow tube reactor under high relative humidity (85–90%). The oxidation products and kinetics are monitored using thermal desorption chemical ionization mass spectrometry (TD-CIMS) and gas chromatography- mass spectrometry (GC-MS). We observed that the glutaric acid – ammonium bisulfate aerosol mixture giving a higher ketone-to-alcohol ratio of the first-generation products during OH-initiated oxidation. Whereas, in the glutaric acid–sodium sulfate mixture, higher fractions of the glutaric aerosol particles undergone fragmentation, resulting in substantial formation of highly oxidized low molecular weight species such as oxalic acid, glycolic acid, glyoxylic acid, and malonic acid. These results imply that the radical chemistry and oxidation kinetics of organic aerosols may vary significantly depending on the inorganic salts in the mixture. The study emphasizes the importance of the acidity effect in heterogeneous oxidation kinetics of organic aerosols and their influence on the oxidation product compositions.

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2TA.12

Revisiting Multiphase Reactions in Deliquesced Aerosol Particles in the Presence of NO2 and SO2. NANAMI EMORI, Masao Gen, *Chuo University*

Nitrogen dioxide (NO_2) is a crucial precursor to nitrate via heterogeneous hydrolysis. It is a key oxidant in multiphase sulfur dioxide (SO_2) oxidation, which is recognized as the primary source of sulfate production during Beijing haze episodes. However, the multiphase reaction of NO_2 and SO_2 in deliquesced aerosol particles remains elusive due to competing pathways. Here, we examine the kinetics of multiphase reactions in deliquesced aerosol particles in the presence of NO_2 and SO_2 using an aerosol flow cell coupled with Raman spectroscopy. Results show pH-dependent competition between nitrate and sulfate production. Specifically, the sulfate production rate increases from 1.3×10^{-7} to 1.1×10^{-5} mol kg^{-1} s^{-1} as pH increases from 5.2 to 6.1. The nitrate production rate at pH = 5.1 is 46 times higher than at pH = 5.3, highlighting the competitive pathways in sulfate and nitrate production. We observe enhanced sulfate production in air relative to N_2, with enhancement factors of ~50, 42, and 25 at particle pH values of 5.3, 5.7, and 6.1, respectively. This enhancement reflects an unaccounted-for reaction pathway involving the reaction of NO_2 + SO_2 to form sulfite radical anions, which then react with molecular oxygen rather than additional NO_2 to initiate the radical chain reaction for sulfate production. As a result, the present pathway for sulfate production via SO_3^- + O_2 is one order of magnitude higher than the conventional NO_2 pathway. Kinetic calculations predict that the updated NO_2 pathway yields the highest sulfate production rate among the prevailing oxidation pathways involving ozone, transition-metal ions, and hydrogen peroxide at pH > 4.5 under haze conditions. These findings identify the SO_3^- + O_2 pathway as a critical source of sulfate in polluted atmospheres.

2TA.13

A Multilayer Diffusion Framework for Particle-Resolved Modeling of Multiphase Aerosol Chemistry. JESSICA GASPARIK, Daniel Knopf, Nicole Riemer, Matthew Dawson, Jeffrey H. Curtis, *Stony Brook University*

Atmospheric aerosol particles often contain mixtures of inorganic and organic species and may exhibit phase-separated morphologies such as core-shell structures. Particle composition and morphology impact multiphase chemical kinetic (MCK) processes, including gas-phase partitioning and corresponding mixing equilibrium timescales. Existing kinetic multilayer models can represent diffusion and gas uptake in individual or idealized particles, but they are difficult to apply to evolving polydisperse aerosol populations where each particle may differ in size and composition. Robust implementation of an analogous MCK framework within box models with polydisperse aerosol has not been possible due to model limitations. Specifically, kinetic models are very computationally expensive, while box models often parameterize aerosol representations (e.g., modal or sectional models) and limit chemical mechanisms or species available to the model user.

Here, we develop and evaluate a multilayer diffusion treatment for individual particles in the recently coupled PartMC-CAMP modeling environment. Particle-resolved Monte Carlo (PartMC) resolves individual aerosol particles within a well-mixed computational volume. Chemistry Across Multiple Phases (CAMP), a configurable multiphase chemistry package, treats gas- and aerosol-phase chemical processes in the atmosphere. The model supports a flexible framework for integrating new chemical mechanisms and species. We present the model development and evaluation to incorporate species diffusion in individual multilayered particles comprising polydisperse aerosol of evolving size and composition within PartMC-CAMP.

As a first application, we use PartMC-CAMP to simulate the partitioning and subsequent diffusion of ozone within a polydisperse population of shikimic acid ($C_7H_{10}O_5$) aerosol. At atmospherically relevant relative humidity and temperature shikimic acid exhibits a full range of semisolid phase states, making it a model system for reactive uptake onto viscous organic aerosol. The novel modeling environment within PartMC-CAMP enables systematic investigation of the dependency between diffusion depth, particle viscosity, and the number of layers in aging polydisperse aerosol populations.

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2TA.14

Probing Charge-Driven Changes in Interfacial Properties of Microdroplets. FIROZ AHMED, Rebika Tamang, Michael Jacobs, *Texas State University*

Chemical reactions are reported to occur more than six orders of magnitude faster in microdroplets than in a macroscale solution. A possible reason for the distinct chemistry observed in microdroplets is that the thermodynamics of reactive processes can be altered significantly in microdroplets relative to the bulk phase due to their large, exposed surface areas. Several factors are believed to contribute to the accelerated chemistry observed in microdroplets, including the intrinsic electric field at the air–water interface, partial solvation effects, the presence of reactive intermediates, and droplet evaporation rates. However, we propose that electrical charge is one of the key parameters promoting microdroplet chemistry. To investigate this, we used single droplet levitation techniques to probe how the net charges on microdroplets alter their interfacial properties, specifically surface tension. Initially, the effect of net charge on the surface tension of three simple droplet compositions (e.g., non ionic, low ionic strength, and highly ionic) were investigated to establish robust charge measurements across chemically distinct systems. Surface tension measurements were carried out using quasi elastic light scattering (QELS) to assess how interfacial tension evolves with increasing charge. Across all droplet compositions, surface tension remained effectively unchanged as charge increased up to the Rayleigh limit (Q_R), indicating that macroscopic surface tension is largely insensitive to net charge in these systems.

To explore how charge can influence the surface compositions of microdroplets, we measured the surface tensions (and compositions) of surfactant containing microdroplets. Microdroplets composed of cetyltrimethylammonium bromide (CTAB) in 30% glycerol–water were used to probe how electrostatic effects influence surfactant organization at charged interfaces. It was observed that the surface tension of CTAB-laden microdroplets increased with increasing net positive charge, suggesting CTAB molecules were electrostatically stripped from the microdroplet surface. These results suggest that charge may influence microdroplet chemistry through changes in interfacial molecular compositions. Going forward, this finding will help us directly correlate charge dependent interfacial compositions with redox reaction kinetics, including hydrogen peroxide formation, to establish mechanistic links between electrostatics and microdroplet reactivity.

2TA.15

In Situ Characterization of Secondary Organic Aerosol Physicochemical Properties via Fluorescence Probe Spectroscopy. MICHAEL BOADU, Paul Ohno, *Auburn University*

Secondary organic aerosol (SOA) physicochemical properties such as hygroscopicity, degree of oxidation, phase state, pH, and viscosity influence important processes that ultimately impact air quality and climate. Due in part to the experimental challenge of in situ characterization, these physicochemical properties remain incompletely understood. Here, an aerosol fluorescent labeling methodology in conjunction with a fluorescence aerosol flow tube (F-AFT) was used for in situ physicochemical characterization of α-pinene and toluene SOA. The wavelength of maximum emission λmax of the fluorescent probe Prodan was shown to depend on the hygroscopicity, degree of oxidation, and relative humidity (RH)-dependent phase transitions of the SOA. At varying RH, λmax was shown to be linearly correlated with % water content. For fixed RH and varying SOA oxidation conditions, the λmax was linearly correlated with the SOA oxygen-to-carbon ratio (O:C). Finally, the λmax of mixed toluene SOA/ammonium sulfate particles indicated that these mixed particles were liquid-liquid phase separated within RH range of 40 to 80 %RH. Overall, these results demonstrate the power and versatility of this approach for direct, online physicochemical analysis of SOA.

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2TA.16

Detection and Comparison of Organic Peroxides Across Biogenic Secondary Organic Aerosol via Iodometry-Assisted High-Resolution Mass Spectrometry. MARIA FLORES, Erik Jackson, Véronique Perraud, Lisa Wingen, Sergey Nizkorodov, Celia Faiola, *University of California, Irvine*

Secondary organic aerosol (SOA) generated from β-ocimene oxidation was recently shown to have an unexpected amount of highly oxygenated organic molecules (HOM) compared to other biogenic SOA. One of the proposed mechanisms for generating the HOM is autooxidation followed by oligomerization between the resulting hydroperoxide and an aldehyde to produce peroxyhemiacetals and other organic peroxides. However, organic peroxides were not directly detected in previous experiments. We address this knowledge gap by leveraging an established method that combines an iodometric assay, which selectively removes peroxides from the mixture, with high-resolution mass spectrometry. We generate biogenic SOA using an oxidation flow reactor via photooxidation of β-ocimene, β-myrcene, α-pinene, d-limonene and 1,8-cineole at mixing ratios < 100 ppb. SOA is collected on filters, extracted, subjected to potassium iodide (KI) under acidic conditions, and analyzed with liquid chromatography and high-resolution mass spectrometry to identify the presence of organic peroxides. KI-sensitive and KI-recalcitrant chromatographic peaks are identified by comparing chromatograms of treated and untreated filter extracts of each sample. The fraction of KI-sensitive formulas provides information about peroxide content in SOA, and oxygen atom distribution in the formulas identified as peroxides helps evaluate the proposed role of HOM in formation of these SOA.

2TA.17

Evolution of Organic Aerosol in near Field Wildfire Smoke. SUMIT GUPTA, Pedro Campuzano-Jost, Jose-Luis Jimenez, Hongyu Guo, Melinda Schueneman, Lu Xu, *Washington University in St. Louis*

Organic aerosol (OA) in wildfire smoke can evolve rapidly with age, with primary OA (POA) evaporating and oxidizing while secondary OA (SOA) condenses. Because these opposing processes largely offset, bulk OA enhancement ratios often appear nearly conserved, hiding whether the disappearing primary material is itself the source of the secondary OA that forms, or the two merely share a common dependence on plume age. We analyse positive matrix factorization (PMF) factors from a high-resolution time-of-flight aerosol mass spectrometer aboard the NASA DC-8 during the 2019 FIREX-AQ campaign, using flights that repeatedly transected the Williams Flats fire plume. Crosswind transects are organized into pseudo-Lagrangian sequences following air masses downwind of the fire. For each transect we compute CO-normalized enhancement ratios of every organic PMF factor and examine how the primary and oxygenated factor groups evolve with smoke age, testing association, age-mediated conversion of lost POA into SOA, and coupling beyond the shared age trend. PMF-independent spectral tracers (f44, f60) corroborate the factor behaviour. Resolving whether wildfire SOA forms from the evaporating primary material itself, or independently from co-emitted precursors, provides a direct observational constraint on how plume and chemical transport models should couple POA loss to SOA production in aging smoke.

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2TA.18

Investigating the Chemical Evolution of Biomass Burning Emissions from Tall Wheatgrass and Longleaf Pine Needles via Daytime (OH) and Nighttime (NO3) Oxidation. MATSON POTHIER, Ed Fortner, Yuzhi Chen, Zezhen Cheng, Andrew Lambe, *Aerodyne Research Inc.*

Biomass burning emissions (BBE) include a variety of gases and particles that significantly affect air quality and climate. These emissions react with daytime (OH) and nighttime (NO3) atmospheric oxidants; however, research on their evolution through both daytime and nighttime oxidative chemistry, as well as the resulting effects on physicochemical properties and secondary organic aerosol (SOA) formation potential, remains limited. Recently, a Potential Aerosol Mass Dual Oxidative Flow Reactor (Dual PAM-OFR) was developed to simulate both daytime and nighttime oxidation of the same BBE source. The Dual PAM-OFR was integrated into a suite of state-of-the-art BBE generation and measurement techniques at Pacific Northwest National Lab's Environmental Molecular Sciences Laboratory in Richland, WA. We investigate SOA formation potential and changes in particle mass, number count, size distribution, as well as chemical composition and optical properties across several combustion temperatures and oxidant exposures for two BBE fuel types – Tall Wheatgrass and Longleaf Pine Needles. Our results show a systematic increase in particle O:C with both increases in combustion temperature and oxidant exposure. Additionally, we observe increases in the mass absorbing cross section of aerosol from NO3 oxidation and a decrease during OH oxidation. These differences in BBE properties associated with OH- and NO3-driven oxidative aging are not currently included in regional/global chemical transport models, and our results will aid in the model treatment of diel atmospheric oxidative aging of BBE.

2UA.1

Mapping Microbial Exposure in Urbanized Arid Environments Through the Integration of Dust Regimes and Meteorological Parameters. AZHAR SIDDIQUE, Kashif Rasool, Shamjad Moosakutty, Bilal Sajjad, M. Rami Alfarra, *Hamad Bin Khalifa University, Doha, Qatar*

A comprehensive understanding of airborne microorganism dynamics in arid urban settings is crucial for assessing public health risks associated with dust storms and extreme climatic events. This research investigates the seasonal variations and meteorological factors that influence culturable bacterial and fungal bioaerosols at ten locations throughout Doha, Qatar. We introduce a novel dust classification framework based on empirically derived thresholds of PM_{10} and the $PM_{2.5}/PM_{10}$ mass ratio to categorize atmospheric conditions into three regimes: "Normal," "Urban Dusty," and "Dust Storm." Airborne samples were collected by high-volume impingement, and microbial concentrations, PM, and meteorological data were analyzed using Generalized Additive Models (GAMs) and polar wind analyses. Results show bacterial concentrations sharply increased under Dust Storm conditions, with coarse PM_{10} as a key driver of microbial resuspension. In contrast, fungal concentrations peaked in the Moderate season under cooler and more humid conditions, suggesting differing sensitivities to environmental stressors. Wind direction and speed significantly influenced bacterial dispersion, especially during Shamal winds, while fungal distributions were more isotropic and humidity-driven. GAMs revealed non-linear relationships between microbial loads and temperature, humidity, solar radiation, and PM fractions, with distinct thresholds for each biological group.

This approach improves microbial exposure assessment by integrating atmospheric modelling, particle composition, and meteorological data. The results highlight key dust–bioaerosol–climate interactions in urban deserts and offer a framework for exposure risk mapping and early public health warnings in other arid areas.

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2UA.2

Investigating the Relative Performance of PurpleAir and QuantAQ Modulair PM Sensors in Los Angeles as a Function of Aerosol Chemical Composition and Particle Size Distribution. JULIE MEDERO, Lelia Hawkins, Aadi Biswas, Rosemary Garcia, Dominick Gordon, Connor Seto, Alice Yuan, *Harvey Mudd College*

Improvements in affordability of PM sensors have led to broad adoption of these sensors by communities long impacted by local and regional pollution sources. Among them, PurpleAir sensors are among the most widely used due to their especially low cost, ease of deployment, and correspondence to reference grade instruments across a range of conditions. However, each deployment offers new insights into the strengths and limitations of these sensors in a particular environment, especially when the deployment allows collocation of multiple sensors and comparisons to research grade equipment. In this study, we deployed six PurpleAir Flex sensors and five QuantAQ Modulair™ PM sensors alongside an aerosol mass spectrometer (Q-ACSM, Aerodyne) and a Brechtel Scanning Electrical Mobility Sizer in a suburban setting in eastern Los Angeles County. Measurements spanned 40 days through fall 2023 and included periods of onshore flow with cooler, humid conditions and periods of strong offshore flow with warmer, drier conditions, offering the opportunity to directly compare sensor precision and comparative accuracy across the full range of conditions experienced in this region. Results indicated broad agreement within sensor types. Comparisons between the two low-cost sensor types revealed a strong dependence on RH, with Purple Air measurements relatively higher under more humid conditions. Since seasonal meteorological patterns result in very different RH trends, we share analysis that compares these fall results to comparable data collected in summer 2024.

2UA.3

Characterization of Fresh and Aged Structural Fire Emissions. MARYAM GHADIMI, Hovanness Dingilian, Thomas Eckel, Yanyu Zhang, David R. Cocker, *University of California, Riverside*

In January 2025, California experienced two of the most destructive fires in its recent history with the Pacific Palisades and Eaton Canyon Fires. These fires involved many structural and other urban emissions with unique profiles in addition to the burning biomass . These smoke emissions undergo further atmospheric chemical aging, producing more oxygenated products and secondary organic aerosol (SOA) that can further negatively impact downwind community and regional air quality and community health. In this study, urban smoke aging was investigated using a 35 ft^3indoor environmental chamber at controlled environmental conditions. A model of a home consisting of some of the most common building materials in Southern California was burned inside an 4 ft x 4ft x 8ft Aluminum burn chamber and transferred into the environmental chamber and irradiated to simulate smoke plume aging . These building materials include treated lumber, asphalt roofing, carpet, and electronics. Gas-phase Volatile Organic Compounds(VOCs) were monitored using gas chromatography with Flame Ionization Detection (GC-FID), while aerosol number concentration and particle size distributions were measured using a Scanning Mobility Particle Sizer (SMPS) while aerosol density was measured using an Aerosol Particle Mass Analyzer (APM-SMPS). Chemical composition of aerosol were characterized with a High Resolution Aerosol Mass Spectrometer (HR-AMS) with a focus on oxygen to carbon (O/C) ratio, oxidation state of carbon, and additional key m/z biomass burning organic aerosol (BBOA) markers. Further, aerosol aged in the environmental chamber will be compared to that from an oxidation flow reactor (OFR), with an emphasis on the chemical characterization of OFR and environmental chamber aged smoke.

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2UA.4

Characterizing Spatial Heterogeneity in Particulate Matter Using Paired Stationary and Mobile Measurements in Chester, PA. ALEC PIRONE, Benjamin A. Nault, Ellis Robinson, Mina Tehrani, Benjamin Werden, Kirsten Koehler, Keeve Nachman, Ana Rule, Ed Fortner, Tara Yacovitch, Peter F. DeCarlo, *Johns Hopkins University*

Particulate matter (PM) is regulated based on total mass concentration despite being a complex mixture of many different chemicals. Increasing evidence from animal and epidemiological studies suggests that certain components drive adverse health effects more strongly than others. Thus, it is important to measure not only the mass concentration of PM, but also its chemical composition. In September 2021, Johns Hopkins University (JHU) collaborated with Aerodyne Research Inc. (ARI) and Widener University to conduct both stationary and mobile PM_1 measurements in Chester, Pennsylvania. Instruments used for these measurements include two Aerodyne aerosol mass spectrometers (AMS) and a network of moderate-cost sensors (QuantAQ MODULAIR-PM) placed throughout the city. One AMS was operated by JHU at a stationary site at Widener University, while the other AMS was operated by ARI on a mobile lab that conducted both stationary and mobile measurements. We first investigated the overall mass concentration throughout the area using the MODULAR-PM network (6 units), which indicated that the PM_1 mass concentration throughout the city was approximately uniform at given time, with a mean of about 9.38 $\mu g\ m^{-3}$ between 9/10 and 10/6. An evaluation of spatial heterogeneity in particle composition is currently being conducted by comparing mobile ARI AMS measurements to those of the JHU AMS. Future work will allow us to quantitatively investigate whether there are enhancements of specific components throughout the city, as well as whether these enhancements are episodic or continuous. As analysis proceeds, we will be investigating source apportionment utilizing particle composition measurements, wind direction, and positive matrix factorization.

2UA.5

Polluted Tijuana River Emissions as a Point Source for New Particle Formation. JUSTIN HAMLIN, Benjamin Rico, Jena Herbst, Robert Pomeroy, Kimberly Prather, *University of California San Diego*

The Tijuana River (TR) is plagued by degraded water quality from urban runoff and frequent releases of untreated sewage and industrial waste. This water pollution becomes a concern for air quality when it is aerosolized and volatilized at a turbulent branch of the TR. This site is linked to elevated concentrations of Hydrogen Sulfide (H2S) and secondary organic aerosol (SOA) derived particulate matter (PM). However, the evolution from gas-phase emissions to PM enhancement remains in question. In this work, an electric vehicle (EV) outfitted with a suite of instruments was deployed next to the TR at the turbulent hotspot, approximately 0.7 km from a long-term monitoring station (Nestor). River sampling was carried out from midnight to 08:00 local time for six days and compared to Nestor to characterize the evolution of nocturnal aerosol populations. Size distribution measurements from a Scanning Mobility Particle Sizer (SMPS) and Spider-MAGIC identified two new particle formation (NPF) events. Each event originated at the river and was subsequently detected at Nestor. An online chemical ionization mass spectrometer tracked the temporal evolution of VOC signatures, which showed similar evolution as aerosol number concentration. These findings demonstrate that turbulence in the TR is driving nighttime NPF and extends the impact of environmental mismanagement which has impacted communities in South San Diego County for decades.

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2UA.7

Enhanced Measurements of PM2.5 Chemical Composition and Size Distribution in Wilmington, California: II. Preliminary Results from Xact, SMPS, and Aethalometer. CHRISTOPHER LIM, Yumeng Cui, Zihan Zhu, Joseph Salazar, Julia Montoya-Aguilera, Steven Boddeker, Provat Saha, Richard Poon, Jeremy Huff, Sina Hasheminassab, Roya Bahreini, Nga Lee Ng, Eric Holden, Mohammad Sowlat, Payam Pakbin, Stephen Dutz, Jason Low, *South Coast Air Quality Management District*

Wilmington, Carson, West Long Beach (WCWLB), an Assembly Bill 617 (AB 617) designated community in California, is influenced by a complex combination of emission sources, including port operations, goods movement, petroleum refining, oil production, and other industrial activities. To support community-scale air monitoring under the U.S. EPA Enhanced Air Quality Monitoring for Communities grant and the WCWLB Community Air Monitoring Plan (CAMP), South Coast Air Quality Management District (South Coast AQMD) established an air monitoring station in Wilmington.

The station includes an Xact 625i, Aethalometer, and Scanning Mobility Particle Sizer (SMPS), which provide near real-time measurements of particulate trace metals and elements, black carbon, and submicron particle size distributions. This station is also equipped with an Aerosol Chemical Speciation Monitor; its preliminary results and a more detailed site description will be presented in a separate presentation. Together, these measurements provide information on PM2.5 source influences, short-term variability, and aerosol characteristics that are not captured by routine PM2.5 mass measurements alone.

Previous measurements in Wilmington by South Coast AQMD showed strong diurnal patterns in particle number concentrations, with sharp midday peaks in summer and elevated nighttime levels in winter. These trends suggest potential new particle formation events and complex photochemical and nighttime chemical processes. Ongoing measurements at Wilmington are expected to provide further insight into these processes. The Wilmington site also complements advanced monitoring stations in the Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT) in the South Coast Air Basin (SCAB), including sites in Pico Rivera and Rubidoux, enabling comparisons across locations affected by different sources and atmospheric conditions.

In this presentation, we will present preliminary Xact, Aethalometer, and SMPS results from Fall 2025 through Summer 2026, focusing on temporal patterns, source-related signatures, and the value of trace metals and elements, black carbon, and particle size measurements for understanding PM2.5 in Wilmington.

2UA.8

Enhanced Measurements of PM2.5 Chemical Composition and Size Distribution in Wilmington, California: I. Preliminary Results of Aerosol Chemical Speciation Monitor (ACSM) Measurements. YUMENG CUI, Christopher Lim, Zihan Zhu, Joseph Salazar, Julia Montoya-Aguilera, Steven Boddeker, Provat Saha, Richard Poon, Jeremy Huff, Sina Hasheminassab, Roya Bahreini, Nga Lee Ng, Eric Holden, Mohammad Sowlat, Payam Pakbin, Stephen Dutz, Jason Low, *South Coast Air Quality Management District*

Wilmington, Carson, West Long Beach (WCWLB) is one of California's Assembly Bill 617 (AB 617) designated communities because it is disproportionately impacted by air pollution from multiple major emission sources, including two of the largest U.S. ports (the Ports of Los Angeles and Long Beach), large refineries, oil fields, major roadways with high truck traffic associated with goods movement, as well as other industrial emission sources.

As part of a U.S. EPA Enhanced Air Quality Monitoring for Communities grant, and in support of AB 617 Community Air Monitoring Plan (CAMP) implementation in WCWLB, South Coast Air Quality Management District (South Coast AQMD) established an air monitoring station in Wilmington. The station is equipped with advanced, high-time resolution air monitors, including an Aerosol Chemical Speciation Monitor (ACSM), Xact, Aethalometer, and Scanning Mobility Particle Sizer, to characterize the size distribution, chemical composition, and sources of $PM_{2.5}$ in this community. This monitoring station is complementary to the Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT), which includes two additional monitoring stations in the South Coast Air Basin (SCAB), located in Pico Rivera and Rubidoux. These stations provide similar measurements, enabling comparisons among sites with distinct characteristics and different emission sources. This, in turn, will improve our understanding of the $PM_{2.5}$ transport, atmospheric aging, and spatial variability across the SCAB.

These detailed measurements of $PM_{2.5}$ composition can help inform more effective and targeted policies to reduce emissions that will ultimately lead to better air quality in the SCAB. In this presentation, we will provide an overview of the Wilmington monitoring station and present preliminary ACSM results from Fall 2025 through Summer 2026, focusing on diurnal and seasonal trends and source-related chemical signatures. Measurements from the other instruments at this site will be presented separately as the second part of this study.

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2UA.9

Long-Term Trends of PM10-Bound PFAS in Lyon, France (2015-2025). ALEXANDRE ALBINET, Julie Cozic, Albane Barbero, Amandine Fievet, Robin Aujay-Plouzeau, Olivier Favez, Morgane Salomon, Claudine Chatellier, Yohann Baillon, Farid Ait-Ben-Ahmad, Nathalie Bianchini, Nina Huynh, Ahmad El Masri, Ibrahima Diallo, *INERIS*

Per- and polyfluoroalkyl substances (PFAS) comprise a large family of fluorinated chemicals of several thousand individual compounds widely used in consumer products and industrial processes. PFAS are ubiquitous in the environment, including the atmosphere, and can pose substantial risks to human health and ecosystems, largely because of their extreme persistence. Tracking how ambient-air PFAS concentrations and chemical signatures change over time is therefore crucial to support the development of effective regulatory frameworks. The PFAhiStory project aims to reconstruct the historical evolution and long-term trends (2015–2027) of PFAS associated with PM_{10} at an urban site in central Lyon, representative of population exposure in France. This work relies on archived daily PM_{10} filter samples collected under the CARA program (Operational Network for In Situ Observation of PM Chemical Composition and Sources in Urban Environments), coordinated by the French Central Laboratory for Air Quality Monitoring (LCSQA). A complementary campaign from June 2026 to May 2027 will extend the historical record and enable characterization of PFAS gas/particle partitioning. Targeted analyses of 49 PFAS routinely monitored in the environment will be conducted on monthly pooled historical PM_{10} samples, yielding temporal coverage of 33% over the last decade. Finally, statistical approaches will be used to quantify long-term trends in PFAS concentrations. The results presented here will describe the temporal changes in concentrations and chemical profiles for the 49 PFAS associated to PM_{10} from 2015 to 2025. They will be discussed in relation to environmental parameters (PM_{10}, elemental and organic carbon, NO_x and O_3 concentrations) and meteorological conditions.

2UA.10

Gas-Phase Organic Compound Emissions from Urban Wastewater Treatment Plant Sludge and Implications for Air Quality. Jiasi Sun, YINGXI LU, Zhen (Jason) He, Jenna Ditto, *Washington University in St. Louis*

Municipal wastewater treatment and associated sewage sludge management are important components of urban infrastructure, but these processes can emit complex mixtures of gas-phase organic compounds that may degrade air quality in surrounding communities. Anaerobic digestion (AD) is a common process used in wastewater treatment facilities to break down the organic waste in sewage sludge. Treated sewage sludge is often stored at wastewater treatment plants over short periods prior to disposal via land application and other methods. Sludge is known to emit diverse gas-phase organic compounds produced by its constituent microbes and the degradation of constituent organic matter. However, real-time characterization of the evolution of gas-phase organic compound emissions from sewage sludge as it ages during wastewater treatment plant storage and upon land application disposal, and associated impacts on air quality, remains limited.

In this study, gas-phase organic compounds emitted from urban wastewater sludge samples, including raw sludge and two types of AD-treated sludge, were characterized using proton-transfer reaction mass spectroscopy (PTR-MS) as the sludge aged. Gas-phase chemical profiles varied substantially among the sludges studied. Oxygen-containing compounds contributed the most among all the chemical groups, consisting of 78% of emitted compounds from raw sludge and 47%-73% from AD-treated sludges. Sulfur- and nitrogen-containing compounds may represent important odor-active fractions of emissions. Their emissions were reduced by 94% and 88% for the two AD-treated sludges compared to the raw sludge. We also detect several emerging contaminants in sludge emissions, including pharmaceuticals, personal care products, pesticides, cleaning product residues, and other organic contaminants commonly found in urban wastewater systems. The wide volatility range of these measured emissions makes them potentially important aerosol precursors.

By integrating real-time gas-phase organic compound measurements across different aging sludge types with odor analysis and health impact evaluations, our study will build a new understanding of novel sludge treatment processes and their air quality impacts.

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2UA.11

Urban Ultrafine Particle Measurements in Europe and California: Insights from Harmonized Monitoring. Johannes Murg, PETRA KOTNIK, Janice Lam Snyder, Alberto Ayala, *AVL List GmbH, Graz – 8020, Austria*

Ultrafine particles (UFPs, <100 nm) make up the majority of atmospheric particle number concentrations and are increasingly viewed as a necessary complement to mass-based PM metrics. Air pollution remains a significant global health risk [1]. Through Directive (EU) 2024/2881 [2], the European Union has incorporated UFP monitoring, in compliance with EN 16976:2024, into ambient air quality programs, whereas routine regulatory UFP monitoring is not yet established in the United States.

In this study, we evaluate long-term urban UFP measurements in Graz, Vienna (both Austria), and Sacramento, California (USA) using the EN 16976-compliant AVL UltraFine Particle Monitor™. At two Sacramento locations (one influenced by roadway emissions and one representing the neighborhood level), European measurement principles were implemented to ensure comparability. Methodological factors in CPC operation, including the choice of working fluid, are recognized as important for harmonized monitoring and are discussed. The CPCs are fully integrated into three sites in the regulatory ambient air monitoring network in the Sacramento region including calibration, data collection, and reporting. Particle number in the capital region is now just one more routine monitoring parameter.

Daily and weekly variations in particle number concentrations are analyzed alongside other traffic-related and meteorological parameters, with particular attention to differences between weekdays and weekends.

Following normalization for instrumental and meteorological influences, both common patterns and region-specific characteristics in UFP dynamics become apparent. UFP number concentrations respond strongly to local traffic intensity and microenvironmental conditions. Seasonal differences at the same site are also observed. These results underscore the need for standardized international UFP monitoring to enable meaningful site intercomparisons and to establish a reliable data basis for future policy development in Europe and the United States.

References:
[1] WHO, Ambient air pollution, Fact sheet, 2023.
[2] Directive (EU) 2024/2881, Official Journal of the European Union, 2024.

2UA.12

Hyperlocal Mobile Monitoring of Particle-Bound Metals in South Los Angeles. ZIHAN ZHU, Yumeng Cui, Joseph Salazar, Steven Boddeker, Christopher Lim, Provat Saha, Julia Montoya-Aguilera, Mohammad Sowlat, Payam Pakbin, Stephen Dutz, Jason Low, *South Coast Air Quality Management District*

Metals constitute an important fraction of ambient particulate matter (PM), some of which are classified as air toxics that can affect public health, particularly in communities located near sources, including industrial facilities, freeways, and major roadways. Conventional fixed site monitoring networks often lack the spatial resolution needed to characterize localized emissions and exposure at the community scale. The South Los Angeles community, designated under Assembly Bill 617 as one of the disproportionately impacted communities in the South Coast Air Basin, faces disproportionate burdens due to the proximity of its residential areas to metal processing and manufacturing facilities as well as major freeways, roadways, and transportation corridors. In order to generate actionable high-resolution data that supports emission reduction strategies by identifying areas where levels of pollution is elevated and using that information to inform compliance and enforcement actions, such as prioritizing facility inspections, mobile monitoring surveys were conducted using a previously developed multi metals mobile platform (MMMP). This mobile platform enables high-time resolution measurements of particle bound metals alongside the other air quality variables such as black carbon, particle numbers, PM2.5, PM10, CO2, NOx, wind speed and direction. The surveys were designed to capture spatial variability in pollutant concentrations to identify areas with elevated levels of particulate metals that were potentially associated with nearby industrial activities. In this presentation, an overview of the monitoring approach and a summary of preliminary findings from the mobile monitoring surveys will be provided. Results demonstrate the value of mobile monitoring in resolving fine scale spatial patterns and in supporting source identification efforts. The findings also highlight how such data can inform targeted follow up investigations, guide regulatory and enforcement actions, and ultimately support strategies to reduce emissions and community exposure to particulate bound metals in disproportionately impacted areas.

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2UA.13

Short-Term Particulate Matter Concentration Increases Observed by Low-Cost Sensors Downwind of Nightly Fireworks from a Theme Park in Orange County, California.

DANIEL B. CURTIS, Anita Abazi, Johana Sosa, Jane Pasa, Mayra Acevedo, Tyler Deflin, Zeinab Khalil, Man Bui, Angela Escamilla, *California State University, Fullerton*

Fireworks are known to emit large quantities of particulate air pollution and contain metal colorants that may have negative health effects on the population. The scientific literature has primarily focused on the impacts of fireworks on air quality during extreme but transient air pollution events due to widespread use during national holidays and celebrations, such as the July 4 holiday in the United States. However, an understudied source of fireworks pollution is due to nightly or regularly occurring fireworks events. Theme parks, for example, often have nightly or weekly fireworks shows. Although the total air pollution from these events is likely less than pollution during widespread use during holidays, emissions from theme parks may be a source of chronic exposure for those who live in the vicinity and a source of acute exposure for those visiting the parks or nearby hotels.

This study used Modulair PM sensor modules (QuantAQ) to quantify ambient particulate air pollution and wind speed and direction from 2024-2026 on the campus of California State University, Fullerton, located in Orange County, California within the greater Los Angeles air basin. The sampling site was located approximately 8 km downwind of a major theme park complex that has fireworks shows nightly during summer months and on weekends year-round. The Modulair PM sensors detected regular short-term increases in particle concentration approximately one hour after the fireworks show, consistent with wind speed and direction data from the theme park location. Typically, PM2.5 concentrations increased by 30-50 μg m^{-3} over a 10-20 minute period then returned to background levels. Differences were observed between two sensors located at 6 m and 30 m above ground level and will be discussed. Preliminary results for filter-based metal concentrations and black carbon measurements will also be presented. Comparison with the July 4 holiday fireworks period and potential other sources of pollution, such as nearby major freeways and rail lines, will be discussed.

2UA.15

Drivers of Regional Variation in Summertime PM2.5 Across Midwest and Northeast US Cities from 2005-2025.

Erika Hosokawa, HANNAH KENAGY, *University of Minnesota*

$PM_{2.5}$ concentrations in US cities have declined over the last two decades because of significant decreases in emissions of both primary aerosols and gas-phase precursors to secondary aerosol formation. In this work, we explore regional differences in the processes controlling $PM_{2.5}$ concentrations between Midwestern and Northeastern US cities. Using EPA AQS measurements, we find that the temperature sensitivity of $PM_{2.5}$ concentrations in the early 2000s was lower in Midwestern cities than in Northeastern cities; we attribute this difference to variations in SO_2 emissions driven by regional differences in powerplant energy efficiency. In more recent years, the energy efficiencies across regions have become more similar, and hence there is no longer a significant regional difference in $PM_{2.5}$ temperature sensitivity. Additionally, we use CMAQ simulations in 2005 and 2018 to explore how the changes in oxidants and aerosol pH resulting from changes in emissions have altered the relative importance of gas-phase and aqueous-phase oxidation pathways for sulfate aerosol formation in Midwestern and Northeastern US cities. Our results highlight how changes in emissions across regions over the last two decades have altered secondary aerosol formation chemistry in the US.

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2UA.16

Characterization of New Particle Formation from a Composting Site Using Horizontal Flux Measurements.

SANGHEE HAN, Lintong Cai, Ella Ivanova, Nicholas Meskhidze, Markus Petters, *University of California, Riverside*

In a recent study we reported that composting facilities are a significant source of sub-10 nm particles (doi:10.1021/acs.est.5c08034). This study, however, was limited to reporting normalized emission factors relative to CO_2 co-emissions. Building on these initial observations, we quantified facility-level emissions and new particle formation rates using mobile and stationary sampling with two different approaches. First, the traditional inverse Gaussian model approach was used. Mobile measurements obtained from circling the facility captured the spatial distribution of the plume, with particle number concentrations exceeding 10^6 cm^{-3} downwind of the facility. AERMOD simulations using an area source reproduced the observed plume, implying sub-10 nm facility level emissions of 3.2×10^{13} s^{-1}. The implied new particle formation rate is 10^2–10^3 cm^{-3} s^{-1}, which is within the range of environmental chamber studies. Second, a new method was developed to measure aerosol emissions, which involved horizontal turbulent flux measurements combining a sonic anemometer and a condensation particle counter. Aerosol horizontal flux was calculated using a wavelet covariance approach, employing the Continuous Wavelet Transform. The estimated aerosol horizontal flux from measurements ranges from 6.83×10^5 to 5.83×10^7 cm^{-2} s^{-1} with a mean of 7.86×10^6 cm^{-2} s^{-1}. The observed horizontal flux magnitudes were constrained using horizontal fluxes derived from large eddy simulations (LES). Estimated emission rates from flux measurements were 5.9×10^{12}–3.1×10^{14} s^{-1}, which is similar to the emission rate estimated with the inverse Gaussian plume approach. These results suggest that horizontal turbulent flux measurements might be a suitable tool for fence line aerosol emission monitoring.

2UA.17

Spatial and Temporal Variability of PM2.5 Composition and Sources in California's San Joaquin Valley: Insights from a Multi-Year Study in Fresno and Bakersfield.

CHRISTOPHER NIEDEK, Ashutosh Kumar Shukla, Justin Trousdell, Ryan Farley, Wenqing Jiang, Chinmoy Sarkar, Morteza Amini, Qi Zhang, *University of California, Davis*

The San Joaquin Valley (SJV) of California is among the most $PM_{2.5}$-polluted regions in the United States. Persistent air quality problems in the region arise from the combined influences of anthropogenic emissions, complex valley topography, and meteorological conditions that favor pollution accumulation and secondary aerosol formation. To investigate the chemical drivers of $PM_{2.5}$ pollution in major SJV urban centers, two aerosol chemical speciation monitors (ACSMs) were deployed in Fresno and Bakersfield, two urban centers in the SJV. These instruments provided sub-hourly measurements of non-refractory $PM_{2.5}$ (NR-$PM_{2.5}$) composition from June 2023 to November 2025, supported by co-located air pollution and meteorological observations. ACSM total NR-$PM_{2.5}$ measurements showed strong agreement with co-located FEM monitors, demonstrating their reliability for routine NR-$PM_{2.5}$ composition monitoring. Substantial spatial and temporal variability in $PM_{2.5}$ concentration and composition were observed at both sites, including pronounced interannual and seasonal differences. Although total $PM_{2.5}$ generally decreased annually during the study period, exceedances of the 24-hour National Ambient Air Quality Standards (NAAQS) remained frequent, especially in winter. Seasonal composition shifted markedly, with organic aerosol dominating in summer and nitrate and oxygenated organic aerosol (OOA) increasing substantially during winter. Analysis of the OOA and O_x (O_3+NO_2) relationship indicated highly efficient wintertime OOA formation compared to other major urban centers (e.g. Mexico City, Houston). While Bakersfield had generally higher levels of gas-phase pollutants, Fresno typically had higher loadings of NR-$PM_{2.5}$. Fresno and Bakersfield also differed in residual-layer chemistry, with enhanced nighttime nitrate formation in Fresno contributing to morning spikes in particulate nitrate that can be twice as high as morning nitrate loadings in Bakersfield. Together, these findings show that, despite shared regional influences on Fresno and Bakersfield $PM_{2.5}$ pollution, boundary layer dynamics and nocturnal processing can vary substantially across SJV cities and strongly shape local $PM_{2.5}$ composition.

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2UA.18

Smog Pollution in Lahore: Causes, Consequences, and Control. HAIDER KHWAJA, M. Akhyar Farrukh, Nimra Afzal, Muhammad Kamran Khan, Saiyada Shadiah Masood, Mirza M. Hussain, *University at Albany*

Severe smog pollution has become a persistent environmental and public health crisis in Lahore, Pakistan, particularly during the winter season when meteorological conditions favor pollutant accumulation. This study provides a comprehensive baseline assessment of fine particulate matter (PM2.5) composition, sources, and associated health risks during peak smog periods. Multiple high-intensity pollution episodes were recorded, with mean and peak PM2.5 concentrations of 262 µg/m3 and 420 µg/m3 , respectively—approximately 7.7 to 28 times higher than the World Health Organization annual guideline (15 µg/m3). Elevated levels of black carbon (BC) and trace elements further highlight the severity of the pollution burden.

Source apportionment using Positive Matrix Factorization (PMF) identified five major contributors: soil and urban dust resuspension, sea spray, vehicular emissions, oil combustion, and industrial activities. Health risk assessment revealed that non-carcinogenic risks associated with PM2.5 and BC exposure via inhalation exceeded acceptable thresholds for both adults and children. Additionally, significant carcinogenic risks were identified due to exposure to PM2.5 - bound toxic elements, particularly chromium (Cr) and arsenic (As).

The findings underscore the urgent need for integrated mitigation strategies. Effective interventions include stricter enforcement of environmental regulations, transition to cleaner energy sources, improved public transportation systems, industrial emission controls, and sustainable agricultural practices - especially alternatives to crop residue burning. Addressing Lahore's smog crisis requires a coordinated, multi-sectoral approach combining policy action, technological innovation, and community engagement to achieve long-term air quality improvement and safeguard public health.

2UA.19

Investigation of Site-Specific Chemical Driver of PM2.5 Oxidative Potential Predictability Using Explainable Machine Learning. NHAN DINH NGO, P. S. Ganesh Subramanian, Yuhui Zhai, Lam Khang Nguyen Duy, Vishal Verma, *University of Illinois Urbana−Champaign*

Oxidative potential (OP) is defined as the capability of fine particulate matter ($PM_{2.5}$) to induce oxidative stress and has therefore emerged as a proxy for $PM_{2.5}$ toxicity. However, the spatiotemporal distribution of OP has shown much more variability across the locations than traditionally measured $PM_{2.5}$ mass, suggesting that learnability of OP has to be constrained under specific chemical regimes.

In this study, we investigate the OP predictability driven by the chemical compositions across five sites in the Midwestern United States. By using machine-learning (ML) models combined with SHAP-based explainability, our results demonstrate that the OP predictability is strongly governed by a limited subset of chemical components - primarily carbonaceous species and redox-active metals - with strong site-specific dependencies. SHAP analyses further elucidate that OP responses are not merely linear; instead, they arise from a combination of linear, nonlinear threshold, and synergistic interactions, with substantial variability across sites and OP endpoints. In particular, metal-driven OP exhibits a nonlinear threshold, while certain chemical species that only constitute a minor fraction of PM mass dominate the OP response under specific chemical regimes.

These findings provide mechanistic insight into the heterogeneous predictability of OP and demonstrate that predictive models are not universally transferable across sites due to distinct chemical regimes. Consequently, this work highlights the utility of explainable machine-learning (xAI) frameworks for improving the interpretability and robustness of OP-based air quality assessments.

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2UA.20

Assessment of Air Quality Parameters in Elizabeth, New Jersey Using Community-Scale Air Quality Monitoring Network: Initial Observations. SEYEDEH REYHANEH SHAMS, Jackie Park-Albaum, John Evangelista, Clinton J. Andrews, Jie Gong, Sunyoung Kim, Deborah Plotnik, Jennifer Senick, Gediminas Mainelis, *Rutgers, The State University of New Jersey*

A community-scale air quality monitoring network consisting of 12 MODULAIR (QuantAQ) sensors was deployed across Elizabeth, New Jersey, to characterize the spatial and temporal variability of urban air pollutants and meteorological conditions. Approximately two years of data (2024–2026) were analyzed to assess network averages across seasons and estimate interannual trends for ozone (O_3), nitrogen dioxide (NO_2), carbon monoxide (CO), particulate matter (PM_1, $PM_{2.5}$, PM_{10}), relative humidity (RH), and temperature (T).

Pollutant analyses revealed clear urban atmospheric patterns driven by traffic emissions, seasonal photochemistry, and meteorological variability. O_3 exhibited elevated warm-season concentrations, with an overall mean of 31.62 ppb and summer averages of 37.79 ppb, consistent with intensified photochemical production during warmer months. In contrast, NO_2 and CO displayed patterns characteristic of combustion-related emissions. NO_2 had an overall mean of 25.40 ppb, with the highest seasonal average in winter (28.92 ppb), while CO showed an overall mean of 713.23 ppb and slightly elevated fall and winter averages exceeding 726 ppb. Particulate matter concentrations demonstrated substantial temporal variability across the network. PM_1 and $PM_{2.5}$ exhibited overall mean concentrations of 6.17 μg/m³ and 7.06 μg/m³, respectively. PM_{10} concentrations were comparatively high (mean = 69.33 μg/m³), influenced by the absence of heated sampling inlets, which led to elevated coarse particle measurements during fog events. Seasonal maxima for particulate matter generally occurred in spring and summer.

Interannual analyses indicated relatively stable pollutant patterns from 2024 through 2026, with moderate year-to-year variability observed for O_3 and particulate matter. Overall, the dense, community-level monitoring network effectively captured fine-scale seasonal and temporal changes in air quality within an environmental justice community in Elizabeth, New Jersey.

2UA.21

New Insights Into Reduced Nitrogen Species Across Gas and Particle Phases in Agriculturally Influenced Urban Air Using Acetone-Ionization CIMS. WENQING JIANG, Ashutosh Kumar Shukla, Harald Stark, Anita Avery, Mitchell Alton, Manjula Canagaratna, Douglas Worsnop, Chinmoy Sarkar, Morteza Amini, Qi Zhang, *University of California, Davis*

Reduced nitrogen species, including ammonia (NH_3), amines, amides, imines, and N-containing heterocyclics, are ubiquitous in the atmosphere and strongly influence aerosol formation, neutralization, and growth, yet their gas-particle partitioning and multiphase processing remain poorly constrained. Here, we used acetone-ionization Vocus chemical ionization mass spectrometry (CIMS) coupled with a FIGAERO inlet to characterize reduced nitrogen in both gas and particle phases during the January – February 2024 winter period in Fresno, California, a polluted city strongly influenced by regional agricultural emissions from livestock operations and fertilizer use. A broad range of reduced nitrogen compounds was detected in both phases. CIMS measurements agreed well (r^2 = 0.92 and 0.86) with collocated Picarro for gas-phase NH_3 and aerosol mass spectrometer for particulate ammonium. NH_3 dominated the alkaline gas budget, averaging 11.8 ± 8.1 μg m^{-3}, several hundred times higher than methylamine (MA) and dimethylamine (DMA) – two dominating amines. The mean particle fraction, defined as f_p = [particle]/([gas] + [particle]), was 0.085 ± 0.047 for NH_3 and higher for MA (0.16 ± 0.045) and DMA (0.19 ± 0.041). Across the broader suite of detected N-containing organics, f_p ranged from 0.065 to 0.45, with most species showing stronger particle association than NH_3. We further evaluated the equilibrium partitioning of NH_3, MA, and DMA using the Extended Aerosol Inorganics Model (E-AIM). E-AIM reproduced NH_3 partitioning well but generally overpredicted MA and DMA particle fractions. Observed particle fractions also increased with decreasing temperature and NH_3 and increasing RH, aerosol liquid water, nitrate, and organic aerosol, pointing to strong environmental controls beyond those captured by equilibrium calculations alone. Together, these results suggest that while NH_3 partitioning is broadly consistent with thermodynamic equilibrium, amines and other reduced nitrogen species are additionally influenced by particle composition, phase state, and kinetic limitations in agriculturally influenced urban air.

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2UA.22

Time Evolution of Atmospheric Water Harvesting Quality: Implications for Storage and Treatment. CARL ABADAM, Jace Chilcoat, Jay Kramer, Katelin Fisher, Rui Liu, Anjali Mulchandani, *University of New Mexico*

Atmospheric water harvesting (AWH) is a technology that condenses water vapor to provide a decentralized drinking water supply during emergencies or periods of water scarcity. However, airborne aerosols, including particulate matter and gases, pose a concern regarding the quality of AWH water since devices often operate near poor air quality from high-emission point sources. There is a need to determine the stability of AWH water quality over time to inform proper storage and post-collection treatment requirements. AWH water was collected (12 separate replicates) over the summer months in Albuquerque, New Mexico (June-August 2026) and analyzed for water quality (pH, total organic carbon, turbidity, conductivity, dissolved metals, ions). Preliminary results show that AWH water quality changed during the first few days of storage. Scanning electron microscopy showed that the filtered particles consisted mainly of aluminosilicates. pH remained stable over the first week of storage (median 6.6 to 6.4, n=12), while dissolved iron, aluminum, and magnesium decreased from median concentrations of 32, 49, and 119 ppb to 17, 26, and 100 ppb, respectively (n=8). Conductivity [µS/cm] decreased from a median of 23.2 to 20.6 (n=12), while turbidity [NTU] decreased slightly after 1 week (median 2.33 to 1.94, n=12). These results indicate that dissolved species are likely being removed from solution through particulate precipitation and settling. The implications of this study will help shape AWH water quality regulations and long-term storage and reuse during times of immediate water need.

2UA.23

Diurnal Variations and Photochemical Influences on Particle-Bound Environmentally Persistent Free Radicals in Subtropical Southern Taiwan. YING I. TSAI, Wei-Cheng Weng, Chen-Shen Tu, Zhi-Yi Xu, Bo-Cheng Lin, Xuan-Yi Lin, Zhen-Lun Tseng, *Chia Nan University of Pharmacy and Science, Taiwan*

Atmospheric aerosols possess highly complex sources and chemical compositions, frequently carrying environmentally persistent free radicals (EPFRs) that remain stable in the atmosphere for hours to days. These particle-bound radicals have recently been recognized as an emerging class of hazardous species that, alongside ambient ozone (O_3) and reactive oxygen species (ROS), pose substantial threats to human health via oxidative stress. To understand the formation and diurnal characteristics of EPFRs in subtropical environments, this study conducted an atmospheric aerosol sampling campaign during the autumn–winter period in Tainan, southern Taiwan. This suburban university site is characterized by a subtropical climate, extended photoperiods (approximately 10–11 hours per day), and elevated ambient O_3 and fine particulate matter (PM) levels. The results demonstrated a distinct diurnal pattern in mass-specific EPFR concentrations (spins per gram of PM due to strong photochemical influences. Specifically, the average daytime EPFR concentrations in $PM_{2.5}$ and PM_{10} were $1.21\times10^{20}\pm1.43\times10^{20}$ spins/g $PM_{2.5}$ mass and $2.47\times10^{19}\pm1.30\times10^{19}$ spins/g PM_{10} mass, respectively. These values were markedly higher than the corresponding nighttime concentrations of $3.67\times10^{19}\pm 2.16\times10^{19}$ spins/g $PM_{2.5}$ mass and $2.12\times10^{19}\pm 8.62\times10^{18}$ spins/g PM_{10} mass. This significant day-night contrast indicates that prolonged solar radiation and active atmospheric photochemical reactions during the daytime substantially enhance the generation and accumulation of radical species. Furthermore, the study highlights that while the radical density per unit mass of particles fluctuates with meteorological and photochemical conditions, the elevated total aerosol loadings (PM mass concentrations) in this region during the autumn–winter season present a critical driving factor for overall population-level exposure. The combination of intense daytime photochemical production and high ambient particle concentrations results in an elevated atmospheric free radical burden and associated health risks in subtropical regions.

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2UA.24

Evaluating Brake-Wear Particulate Matter Emission Reduction Potential from Electric and Hybrid Vehicles.
MICHELIA DAM, Okjoo Park, Seungju Yoon, Yilin Ma, Wilson Chau, Shishan Hu, Gary Mikailian, Jorn Herner, *California Air Resources Board*

Characterizing brake-wear emissions and their potential health effects is becoming increasingly important as tailpipe emissions continue to decrease, through the adoption of electric and hybrid vehicles in California's fleets and other control measures, and brake-wear emissions remain on roads. However, electric and hybrid vehicles also have the potential to reduce brake-wear emissions due to rapidly evolving regenerative braking technologies, which are not well characterized. Therefore, understanding the effects of vehicle operating characteristics (e.g., vehicle weight, speed, acceleration, deceleration, frequency of stops, brake temperature, and other factors) on brake-wear emissions is necessary for developing a comprehensive picture of the PM emissions reduction potential from electric and hybrid vehicles.

California Air Resources Board investigated the relationship between brake-wear PM2.5 and PM10 emissions reductions and vehicle operating characteristics for several electric and hybrid passenger vehicles. Particle mass, number, and size distributions were measured near the test vehicle's brakes over multiple laboratory chassis-dynamometer test cycles for compact, mid-size, and pickup truck/SUV electric and hybrid vehicles. These emissions were compared to those measured for conventional gasoline vehicles in the same weight classes to determine emission reduction potentials and evaluated against previously reported values from brake-dynamometer testing.

Regenerative braking was most efficient in the mid-speed range (15-50 mph), indicating PM2.5 and PM10 emissions could be substantially reduced (>90%) with regenerative braking. This emission reduction potential is much greater than currently represented in California's brake-wear emissions inventory, demonstrating a need to refine estimates accounting for modern vehicle technologies equipped with regenerative braking. Measured brake-pad temperatures stayed roughly 40-90 °C cooler for electric and hybrid vehicles vs gasoline due to minimized friction brake use. Observed brake-wear reduction potential from electric and hybrid vehicles across California's light-duty fleet helps assess the co-benefits of California's clean transportation programs and inform future investigations.

2UA.25

Neighbors for Clean Air: Community-Based Monitoring of Airborne Metals in St. Paul, Minnesota.
Kristy Allen, Elizabeth Logas-Lindstrom, Jon Robelia, JACOB SWANSON, Fen Swanson, Danielle Swift, *Minnesota State University, Mankato*

Understanding neighborhood-scale variation in airborne metal concentrations remains challenging because regulatory monitoring sites are too sparse to capture local emission sources and spatial gradients. To address this, the *Neighbors for Clean Air* project established a community-based monitoring network in the Frogtown and Hamline-Midway neighborhoods of St. Paul, Minnesota. The project is a collaboration among Minnesota State University, Mankato, The OSLUV Project, Hamline Midway Coalition, Frogtown Neighborhood Association, JustAir, and community residents.

Approximately 25 monitoring sites were established throughout the study area. Each site collects ambient particulate matter on mixed cellulose ester filters using constant-flow sampling pumps hosted and monitored by community volunteers. Filters are analyzed for trace metals using a modified version of NIOSH Method 7303 that includes inductively coupled plasma mass spectrometry (ICP-MS). Target analytes include As, Ba, Be, Cd, Cr, Co, Cu, Fe, Mn, Ni, Pb, Se, and Zn. Sampling protocols, flow verification, field blanks, duplicate samples, and laboratory quality control procedures are used to ensure data quality.

In addition to measuring airborne metals, the project emphasizes community participation in monitor operation, public access to air quality data, and communication of results through workshops and an online dashboard. The monitoring network is intended to complement existing regulatory measurements by providing higher spatial resolution across an urban neighborhood with multiple potential emission sources, including traffic and industrial activities.

This presentation describes the monitoring network, sampling methods, the design of the outdoor sampling apparatus, the online data display, and the overall project design. The project demonstrates how established aerosol sampling methods can be combined with community partnerships to generate neighborhood-scale measurements of airborne metals while supporting public engagement in air quality monitoring.

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3AP.1

Turbulence, Surface Complexity, and Morphology Controls on Submicron Particle Dry Deposition: Insights from a Controlled Chamber Study. JONAH HAZELWOOD, Markus Petters, Nicholas Meskhidze, *North Carolina State University*

Size-resolved particle dry deposition velocities (v_d) for submicron particles remain among the largest sources of uncertainty in regional and global aerosol models, yet controlled laboratory constraints on the governing mechanisms are scarce. We conducted experiments in a spherical aluminum chamber (diameter 91.4 cm, volume ~0.4 m^3) to systematically investigate how turbulence intensity, surface type and complexity, and particle morphology govern v_d across the 15–300 nm mobility diameter range.

Deposition velocities were determined using two independent methods: a chamber concentration decay approach and a direct filter collection and re-atomization technique. Three aerosol types with distinct morphological and compositional properties were examined: sodium chloride (NaCl), polystyrene latex (PSL) spheres, and black carbon (BC) aggregates generated by ethylene combustion.

Key findings are threefold. First, turbulence exerts strongly size-dependent control on v_d: viscous sublayer suppression produces a local minimum near 70–150 nm under intermediate turbulence regimes, an effect that diminishes at higher turbulence intensities. Second, flow-permeable, vegetation-like surfaces enhance normalized v_d by factors of 2–3 for particles smaller than 50 nm, substantially exceeding predictions based on surface area alone and highlighting the importance of surface morphological complexity in deposition parameterizations. Third, particle morphology introduces up to an order-of-magnitude spread in v_d at a given mobility diameter: BC fractal aggregates exhibit a characteristically flat v_d-size relationship inconsistent with spherical-particle parameterizations currently used in models. Filter-derived v_d values for PSL particles (170, 195, and 308 nm) agree with decay-method results to within a factor of 2, validating filter collection as an independent and quantitatively reliable measurement approach. Given BC's chemical inertness and recoverability from filter surfaces, these results motivate deployment of analogous filter-based methods for direct, size-resolved v_d measurements under ambient atmospheric conditions.

3AP.2

Time-Resolved Measurements of Nanolitre Droplet Fission in Strong Electric Fields. NATHAN CROLL DAWES, Anish Doshi, Jim Walker, Bryan R. Bzdek, *University of Bristol*

Chemical reactions can be dramatically accelerated in aerosol droplets, with reaction enhancement factors in droplets relative to macroscopic solution reaching up to 10^7-fold. Several hypotheses for this accelerated reactivity have been proposed involving interfacial processes, with many of them relying on a strong understanding of interfacial composition and reactivity. However, vanishingly few techniques can directly probe the interfacial chemistry of airborne droplets. In Field Induced Droplet Ionisation (FIDI), a droplet is subjected to a strong, uniform DC field. If the field is strong enough, interfacial forces are overwhelmed by electrostatic stress, Taylor cones form, and the parent droplet breaks down into progeny droplets by shearing the parent droplet's surface layer. The resulting spray can be directed to a mass spectrometer for chemical analysis, providing a route for interrogating chemistry at the interface. In the past, FIDI-MS has largely been limited to experiments on large, microlitre, pendant droplets and only rarely has been applied to airborne droplets of nano- and picolitre volumes, as FIDI on smaller droplets requires larger electric fields and contactless manipulation of the droplet. This presentation will introduce a novel FIDI setup, where droplets are generated with a dispenser and stroboscopically imaged while within an electric field, providing highly reproducible and time-resolved dynamics of droplet oscillation and fission as experimental parameters like field strength, droplet surface tension, and droplet viscosity are systematically varied. A framework for understanding droplet behaviour in a uniform DC field will be described, and experiments exploring how time-dependent changes in interfacial composition (e.g. surfactant partitioning) alter FIDI dynamics will be discussed.

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3AP.3

Using Photothermal Interferometry to Study the Heat Transfer from Single, Optically Trapped Droplets in the Transition Regime. FELIX STOLLBERGER, Alexander Bergmann, *Graz University of Technology*

Heat transfer from aerosol particles directly influences processes such as evaporation and growth of atmospheric droplets, combustion in reactive flows and measurements of absorption or mass concentration using photothermal interferometry and laser-induced incandescence. Many particles relevant to these processes lie in the transition regime, where neither free-molecular nor continuum descriptions of heat transfer are fully applicable. For this size range, semi-empirical correction factors (β_T), parameterized by the Knudsen number (Kn) and thermal accommodation coefficient (α_T), are used to extend continuum heat-transfer theory.

A key ambiguity in this framework is the definition of Kn itself. Different models employ different definitions, and recent work suggests that the gas mean free path may be systematically overestimated. Additionally, the material-dependent thermal accommodation coefficient is often assumed to be unity due to the lack of experimental results.

In this work, we measure the thermal response time (τ) of single, optically trapped droplets using multi-frequency photothermal interferometry (nω-PTI). Since τ is governed by the heat conduction rate between the droplet and the surrounding gas, it provides a direct probe of transition-regime heat transfer under controlled conditions. For this purpose, τ is measured as a function of particle radius, determined via static light scattering, and compared with existing theory.

Measurements on tetraethylene glycol droplets in dry N_2 show excellent agreement with theory only when the transition-regime correction is included, even for particles as large as 3 µm in radius. These results establish τ as a direct experimental observable for probing heat transfer from single particles in the transition regime. Consequently, measurements of τ will permit to discriminate between different models for β_T and to constrain the value of α_T for specific substances within each framework.

3AP.4

Volatility of Perfluorinated Carboxylic Acids. Catalina Botero-Carrizosa, Catherine Chang, Emily Halpern, ALEXANDER LASKIN, *Purdue University*

Poly and perfluorinated alkyl substances (PFAS) are contaminants of concern which properties afford them chemical and physical stability causing them to be known as “forever chemicals.” Their accumulation in water, soil, and organisms leads to adverse environmental and health impacts. Within the various types of PFAS, perfluorinated alkyl carboxylic acids (PFCAs) have been widely incorporated in a variety of consumer products. Multiple efforts have been devoted to identify, detect, and quantify PFCAs in liquid and solid samples. However, more information is necessary to understand long-range transport and lifetime of these species in the aerosol form, particularly, as plumes originating from wildfires, agricultural systems, or oceans spray may serve as platforms of introduction into the air. In this study, we develop an innovative experimental methodology for the volatility-resolved targeted detection and quantitation of PFCAs through temperature-programmed-desorption direct analysis in real time (TPD-DART) coupled with high resolution mass spectrometry (HRMS). This method requires no sample preparation and yields temperature-resolved measurements particularly important to quantify volatility and gas-particle partitioning behavior. Through the application of this method, we were able to obtain apparent enthalpies of evaporation and saturation mass concentration which are descriptors of the species volatility. To further understand the impact of our results, we completed a comparative analysis using both the volatilities of PFCAs and of their hydrocarbon counterparts, revealing a consistent pattern of higher values for PFCAs across relevant temperatures. Thus, this work demonstrates a method of detection of PFCAs in aerosol samples that contributes crucial information to understand volatility and to further explore other types of PFAS and their influence in other aspects such as aerosol formation, reactivity, and behavior.

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3AP.5

Imaging Airborne Droplets: A Novel Instrument for Exploring Physical Changes in Aerosol Droplets Using Brightfield Imaging. ANNA CATTON, Fraser Crawford, Jim Walker, Nathan Croll Dawes, Jonathan P. Reid, *University of Bristol*

The drying and condensation dynamics of aerosol droplets are important processes in a range of high-profile applications, including in pharmaceutical production and the food industry. Single droplet analysis is a powerful approach to explore the dynamic behaviour of aerosols and provide empirical data for validating cutting-edge water transport models. For most single particle measurements, elastic light scattering can be readily used to retrieve the size of spherical liquid droplets. However, this approach cannot be used for inhomogeneous and non-spherical particles and is limited to returning coarse estimations for the morphological structure. Here, we report the integration of high resolution brightfield imaging with an electrodynamic balance (EDB) to observe the phase behaviour and mass transport kinetics of single aerosol particles during evaporation and condensation. The stroboscopic approach enables individual images to be captured at a frequency of 100 Hz and uses a narrow 500 ns illumination pulse to minimise motion blur, allowing the motion, size and morphology of trapped particles to be interrogated in detail. In combination with elastic light scattering, robust phase analysis of an aerosol particle can be achieved and particle geometric and optical sizes compared. The addition of stroboscopic imaging allows high-fidelity and high time-resolution studies of evolving mass-to-charge ratio, aerodynamic size, water content and phase, for fully understanding the mass transport kinetics. We will report unique measurements of the microphysical dynamics of particle crystallisation and the formation of buckled dry particles formed on drying solution droplets of nanoparticles. The possibility of probing the dependence of water condensation on the formulation of particles from dry powder inhalers used to treat asthma will be discussed.

3AP.6

Impact of Nonionic Surfactants on Water Activity. ALISON BAIN, *Oregon State University*

Some field measurements of cloud condensation nuclei (CCN) concentration observe more CCN than are predicted using common assumptions in Köhler theory. Surfactants, which partition between the aerosol droplet surface and bulk, have been suggested to explain this difference. As surfactants partition to the droplet interface, they can reduce the droplet's surface tension, thereby reducing the Kelvin effect and the barrier to cloud droplet activation. However, as surfactants partition out of the droplet bulk, they may also increase the droplet's water activity, which counteracts the effect on critical supersaturation. The impact of surfactant partitioning on water activity and how it should be described to predict cloud droplet formation has received less attention than surface tension.

Here, we describe measurements of the water activity of aqueous solutions containing strong, nonionic surfactants and their mixtures with cosolutes. Measurements are compared to predictions of water activity from the online AIOMFAC (Aerosol Inorganic-Organic Mixtures Functional groups Activity Coefficients) model. Strong surfactants with a polyethylene glycol (PEG)-like tail (e.g., Triton X-100 and Tween20) can be described using either ether/alkyl subgroups or oxyethylene subgroups. For such systems, we find predictions using the oxyethylene subgroup descriptions show better agreement with measured water activity. We also use these different approaches to describe aerosol water activity in Köhler theory for aerosol undergoing hygroscopic growth and cloud droplet activation. Comparisons to laboratory CCN measurements also show that the oxyethylene subgroup approach to describing aerosol water activity outperforms the ether/alkyl subgroup approach.

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3BA.1

Water-Soluble Aerosol Collection Medium for Environmental Bioaerosol Collections. KEVIN K. CROWN, Sean Kinahan, Gabriel A. Lucero, Eric Carnes, Yury Salkovskiy, Aleksandr Fadeev, Joshua L. Santarpia, *National Strategic Research Institute*

When polyvinyl alcohol (PVA) is electrospun into a nanofiber mat, a water-soluble aerosol collection medium is created with high collection efficiencies that are hospitable to active viruses. This collection medium allows aerosolized biological targets to be analyzed through methods that include propagation and Polymerase Chain Reaction (PCR). This nanofibrous medium was shown to be biologically hospitable while in solution with no signs of PCR inhibition upon post-collection and no appreciable change in solvent viscosity or pH after dissolution. Because this medium dissolves completely in aqueous buffer, 100% of the collected sample is liberated from it allowing the entire collected sample to be available for analysis. Increased particle extraction from a water-soluble collection medium increases the detection sensitivity of biological particles relative to water-insoluble media like glass or polymer. Since PVA bioaerosol collection media dissolve in small amounts of aqueous liquid without significantly increasing the viscosity of what they are dissolved in, they work well in automated microfluidic systems used to transport the collected sample to a point of analysis which may also be automated.

3BA.2

Automated Airborne Viral Sampling Using an Electrostatic Particle Concentrator with a Conical Collection Electrode. NHAN DINH NGO, Thanh H. Nguyen, Vishal Verma, *University of Illinois Urbana−Champaign*

Over recent decades, epidemics and pandemics of respiratory viral diseases, such as flu and COVID-19, have caused significant economic losses and numerous deaths. Effective sampling of airborne viruses with high enrichment and preserved infectivity is critical for rapid measurement and response.

Here, we develop an eBioSampler - an automated airborne virus sampling system utilizing a liquid-based electrostatic particle concentrator (EPC) equipped with a programmable syringe pump system. This configuration automatically withdraws collected samples and supplies fresh buffers to maintain a continuous liquid layer over an electrode, thereby enabling continuous and unattended airborne viral sampling.

The eBioSampler was validated against the SKC BioSampler and a conventional filter (Gelatin) sampling system used as standard references. Physical particle collection efficiency was assessed using a SMPS (TSI, model 3938) with polydisperse NaCl particles. Biological collection efficiencies were determined using the Influenza A virus (H1N1) strain A/California/07/2009, with viral viability assessed via Tissue Culture Infectious Dose (TCID50) assays.

The eBioSampler achieved nearly 100% physical collection efficiency for particles greater than 50 nm at sampling voltages less than −6 kV. Crucially, it preserved viral viability 19.97 times better than the SKC BioSampler and 74.15 times better than the Gelatin filter. These superior results demonstrate the eBioSampler's capability for efficiently collecting airborne viruses while preserving their infectivity, making it a valuable tool for rapid and accurate viral surveillance.

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3BA.3

Turn It Up: Efficient and High Flow Rate Water Condensation Sampling of Bioaerosols. DREW JONES, Adam Gillison, Emily Kraus, Kristin Rugh, Mark Hernandez, Marina Nieto-Caballero, Kenneth F. Reardon, Sonia Kreidenweis, Shantanu Jathar, *Colorado State University*

Virtual impactors have been coupled with water condensation-based air samplers to sample bioaerosols. The combination of a virtual impactor, which concentrates aerosols, and an air sampler which samples gently and directly into liquid, allows this collection method to be used where low ambient concentrations of the aerosol of interest might otherwise limit its use. The goal of this work was to develop a virtual impactor/water-based condensation sampler pair capable of sampling at volumetric flow rates of 150 L/min or greater. A new single stage virtual impactor was designed with the objective of permitting this flow rate. The concentration factor across a range of aerosol sizes was characterized and the 50% cut-point determined. The virtual impactor was then paired with an Aerosol Devices BioSpot VIVAS, a water condensation-based sampler able to sample at flow rates as high as 15 L/min, allowing a total sampled flow rate of 225 L/min. The integrated concentrator-sampler was then evaluated and compared to unmodified samplers in chamber experiments using both gram-positive and gram-negative bacteria: *Bacillus altitudinis* and *Pseudomonas syringae*, with each experiment run in triplicate. Collection efficacy of genetic material was assessed by qPCR, and the preservation of cell membrane integrity evaluated with PMA-qPCR. The integrated sampler was also used for field bioaerosol sampling in the Summer of 2026 to demonstrate its utility for field work. The benefit of this research is the development of a water condensation-based sampling device with the capacity to sample at greater flow rates directly into liquid where previous methods might have compromised bioaerosol samples by mechanical damage or desiccation, opening new possibilities for time-resolved sampling to better understand aeromicrobiome dynamics. Potential applications of the concentrator-sampler may include outdoor bioaerosol sampling campaigns or rapid infectious disease detection.

3BA.4

Advancing Assessment of Personal Exposure to Viral Aerosols: Evaluation of Two Novel Samplers. XING LI, Taewon Han, Gediminas Mainelis, *Rutgers, The State University of New Jersey*

Accurately measuring personal exposure to airborne microorganisms remains challenging with conventional sampling methods. To address this gap, we developed two novel personal bioaerosol samplers: the Personal Nasal Sampler (PNS) and the Personal Rutgers Electrostatic Passive Sampler (P-REPS). The PNS is worn inside the user's nostrils and relies on natural breathing to capture bioaerosols onto a hybrid low-pressure filter, providing a more realistic representation of inhaled exposure than external personal samplers. The P-REPS is a passive sampler constructed from a permanently polarized ferroelectric PVDF film arranged in a spiral configuration, with oppositely polarized surfaces generating a strong electrostatic field capable of capturing airborne particles in the personal breathing zone.

Both devices were evaluated against the IOM sampler using bacteriophage Phi6 aerosols in a walk-in exposure chamber. The PNS was mounted inside a manikin's nostrils and tested under two conditions: (i) continuous airflow at 5 L/min per nostril and (ii) a realistic waveform breathing pattern generated by a breathing simulator. P-REPS and IOM samplers were positioned in the manikin's breathing zone. After 1 hour of sampling, viral particles were eluted into 2 mL (PNS), 50 mL (P-REPS), and 5 mL (IOM) and quantified using plaque assays and RT-qPCR.

Under continuous airflow, the PNS achieved a 91% collection efficiency (RT-qPCR) and 55% under simulated breathing. Despite lower efficiency than the IOM, the PNS's small elution volume and high sampling flow rate improved the detection limits for viruses. The passive P-REPS captured 17% of the viral load collected by the IOM, corresponding to an equivalent sampling flow rate of ~0.4 L/min, thus demonstrating passive viral capture not achievable with settling-based passive samplers. Together, the PNS and P-REPS offer new capabilities for assessing personal exposure to airborne viruses and other bioaerosols.

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3BA.5

Continuous Aerosol-to-Liquid Bioaerosol Detection with Integrated Virtual Impactor, BioSpot-GEM, and Microfluidics.

QINGQING FU, Elizabeth A. Klug, Braden Stump, Bernard Olson, Joshua L. Santarpia, Christopher J. Hogan, *University of Minnesota*

Characterizing bioaerosols is challenging because pathogen-carrying particles exist at very low concentrations, even in high-risk environments. Thus, a bioaerosol capture system is needed that enables high aerosol sampling flow rates and collection into small, flowing liquid volumes. This continuous collection system may serve as an early warning of airborne transmission.

In this work, we designed, fabricated, and calibrated a compact three-stage virtual impactor (VI) system with an aerosol sampling flow rate of up to 1000 LPM, targeting a concentration factor of nearly 800x for particles ranging from 0.6 to 10 µm. The final-stage VI minor flow rate was set to 1.2 LPM to match the inlet flow rate of a commercial water-condensation sampler (BioSpot-GEM). For the VI design, computational fluid dynamics (CFD) simulations coupled with particle trajectory analysis were conducted to optimize the inlet angle and length for each stage. Experimental results indicate that the 50% cut-off diameter of the impactor and the VI concentration factor agree well with numerical predictions.

For the BioSpot-GEM sampler, a new three-port liquid vial targeting a liquid volume of 50–100 µL, was designed, fabricated, and integrated with a microfluidic subsystem. The size-resolved sampling efficiency of the integrated VI, BioSpot-GEM, and microfluidics is compared with numerical predictions. To better understand the continuous aerosol-to-liquid collection mode, a model was developed to describe the time-dependent mass/pathogen transport from ambient air to a downstream detector. The time-response model, capturing aerosol and liquid concentrations across the VI system, BioSpot-GEM vial, and downstream detector over sampling time, will be presented and discussed.

3BA.6

Towards Real-Time Identification of Pathogenic Bioaerosols.

JOSHUA L. SANTARPIA, Elizabeth A. Klug, Daniel N. Ackerman, Braden Stump, Christopher J. Hogan, Qingqing Fu, Bernard Olson, Dipanjan Pan, Nandhakumar Ponnusamy, Oguzhan Colak, Frankie Meyers, Ragheb El Khaja, Jessica W. Ware, Peter Mercredi, *University of Nebraska Medical Center*

Automated identification of biological aerosols is a currently a multi-step process that involves the collection of particles from the environment, extraction of biological analytes from the collected material and subsequent analysis by either identifying proteins or nucleic acids (NA) associated with known agents of concern. Typically, these systems have been used to detect specific pathogens in order to provide warning of an attack with a biological weapon, and not to provide real-time data to improve public health. The limitations of the current approaches are severalfold. Aerosol is collected over long periods of time (typically hours, bioanalytes are extracted in batches and then tested using techniques like polymerase chain reaction (PCR) or immunoassays. This process requires both time and reagents. Optical bioaerosols systems were originally developed as a replacement for these systems, however, no optical technology is currently capable of confidently discriminating pathogens from non-pathogens, much less confidently identifying organisms at the species level, outside of the laboratory. In this effort we demonstrate a new paradigm for the identification of bioaerosols by continuously collecting, processes and biochemically analyzes bioaerosols moving traditional bio-identification technology closer to the time resolution of optical systems. In this work, we have integrated a multi-stage virtual impactor with a condensation growth tube collector to provide high volume air-to-liquid collection into 50-100 uL volume. The hydrosol is then continuously transferred, via microfluidics, for continuous nucleic acid extraction and electrochemical analysis, resulting in sample to initial detection times of only a few minutes.

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3CC.1

Chemical Characteristics and Light Absorbing Properties of North African Smoke Transported to the Caribbean.

CASSANDRA GASTON, Sujan Shrestha, Phoebe Scharle, Jeffrey Reid, Mira Pöhlker, Andrew P. Ault, Robert Holz, Paquita Zuidema, Zezhen Cheng, Nurun Nahar Lata, Swarup China, Betsy Reid, Rebecca L. Parham, James Christie, Rebecca Chewitt-Lucas, Devon Blades, Edmund Blades, Alyson Allen, *University of Miami*

Every winter and spring, African smoke from fires from sub-Saharan Africa are transported with African dust to the Caribbean and South America. Despite the prevalence of these events, less is known about smoke particles from northern African fires compared to African dust or smoke from southern African fires. During the Moisture and Aerosol Gradients/Physics of Inversion Evolution (MAGPIE) campaign in winter of 2025 in Barbados, unusually large smoke transport events were captured with measurements of aerosol size (SMPS and APS), chemical composition (ACSM and Single Particle Mass Spectrometry), particle light absorbing and scattering properties (aethalometer and nephelometer), and vertical aerosol profiles (HSRL). During the smoke transport events, the Absorption Ångstrom Exponent (AAE) increased to 1 while the single scattering albedo (SSA) reduced to near 0.7—indicating highly absorbing aerosol. Single particle mass spectrometry and offline single particle microspectroscopy revealed that potassium-rich, soot particles dominated the submicron aerosol and mixed with both sea spray and dust. We also performed Optical Photothermal Infrared spectroscopy with simultaneous Raman and fluorescence spectroscopy (OPTIR+Raman+Fluorescence) to characterize the smoke aerosol and its absorption properties. Organic material was negligible, but a strong signal from black carbon was present, including strongly absorbing sp2 carbon-bonds. Taken together, the data suggests that the smoke transported to Barbados is highly absorbing in nature, which is a similar finding to long-range transported smoke in the Southern Atlantic despite the difference in fuel sources.

3CC.2

Seasonal Differences in Contributions of Photochemical, Upwind Cloud and Aerosol Aqueous-Phase Oxidation and Mixed Combustion in Secondary Organic Aerosol Formation in Coastal Southern California.

VERONICA BERTA, Lynn M. Russell, Jeramy Dedrick, Abigail Williams, Sanghee Han, John Liggio, Michael Wheeler, Ryan Farley, Allison Aiken, Markus Petters, *Scripps/University of California San Diego*

Organic aerosol (OA) formation in coastal environments is influenced by both photochemical and aqueous-phase oxidation, but the roles of these pathways in marine cloud-influenced environments are not well constrained. During the Eastern Pacific Cloud Aerosol Precipitation Experiment (EPCAPE), a High-Resolution Time-of-Flight Aerosol Mass Spectrometer (HR-ToF-AMS) was deployed at Mt. Soledad in coastal La Jolla, California, to characterize submicron OA composition and oxidation pathways. Positive matrix factorization resolved five OA factors, including hydrocarbon-like OA (HOA) and four oxygenated OA (OOA) factors: sulfate-related OOA (SR-OOA), more-oxidized OOA (MO-OOA), less-oxidized OOA (LO-OOA), and continental OOA (C-OOA). SR-OOA contained methanesulfonic acid (MSA)-related fragments, exhibited correlations with upwind cloud vertical fraction (UCVF) for most of the year, and was associated with bimodal size distributions and marine air masses, indicating marine biogenic origins and formation associated with upwind in-cloud aqueous processing. MO-OOA also exhibited bimodal size distributions and showed seasonally dependent formation pathways, correlating with UCVF during spring and summer months when upwind cloudiness was greatest, but with ozone for most of the year, indicating contributions from both in-cloud aqueous and photochemical processing. In contrast, LO-OOA showed strong correlations with ozone and pronounced midday enhancements across most seasons, indicating consistently photochemical formation. C-OOA was associated with refractory black carbon and other biomass burning tracers, indicating mixed influences from combustion emissions and secondary processing. Multiple linear regression further supported these distinct formation pathways, with SR-OOA primarily associated with in-cloud aqueous processing (70%), MO-OOA reflecting seasonally varying influence from in-cloud aqueous and photochemical oxidation, LO-OOA driven by ozone-related photochemistry (64%), and C-OOA shifting between combustion-related and photochemical influences depending on season. The OA oxidation state given by the oxygen-to-carbon ratio (O/C) was largely explained (R^2 = 0.97) by aerosol water aqueous oxidation (39%) and photochemistry (38%) while in-cloud aqueous oxidation (19%) played a secondary role. Together, these results demonstrate that both photochemical and aqueous-phase oxidation contribute to organic aerosol aging in coastal Southern California, with upwind in-cloud processing playing an important role in the formation of highly oxidized secondary organic aerosol.

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3CC.3

Urban-Rural Comparisons of Cloud Condensation Nuclei Activity in the Baltimore Region: Insights from the CoURAGE Campaign. STEPHANIE JACOBY, Nahin Ferdousi-Rokib, Benjamin A. Nault, Peter F. DeCarlo, Christopher Hennigan, Kenneth Davis, Nicholas Prince, Jenni Kyrouac, Ashish Singh, Maria A. Zawadowicz, Ogochukwu Enekwizu, Akua A. Asa-Awuku, *University of Maryland*

Aerosol-cloud interactions are the largest source of uncertainty in estimates of anthropogenic-induced radiative forcing, hindering accurate climate change predictions. Reducing this uncertainty requires the ability to reliably predict cloud condensation nuclei (CCN) activity, specifically for multi-component ambient aerosols. CCN activity is influenced by particle size and chemical composition with variability across spatial and temporal scales. As a result, modelling large-scale CCN activity can be difficult. Urban environments pose unique challenges due to the prevalence of complex, rapidly evolving aerosol mixtures. This study characterizes the processes and factors contributing to CCN concentrations and variability across urban environments during the 2025 Coast-Urban-Rural Atmospheric Gradient Experiment (CoURAGE). CoURAGE investigated the interactions among the urban, rural, and bay environments in Baltimore to enhance understanding of the urban atmosphere and improve its representation in Earth system models. CCN measurements were obtained using a continuous-flow streamwise thermal-gradient cloud condensation nuclei counter (CCNC) at an urban and rural site near Baltimore, MD, during the spring-to-summer seasonal transition from March to June 2025. Observations suggest that the changes in CCN concentration across the ~60 km urban-rural gradient strongly depend on local wind direction and wind intensities. Specifically, the average ground-level number concentrations of CCN at 0.4% supersaturation were approximately 600 cm^{-3} higher during bay breeze events (southeasterly wind direction) compared to the prevailing westerly and northwesterly winds. This work provides insights into the factors driving CCN activity in the Baltimore region, enhancing our understanding of how to effectively represent CCN activation in Earth System Models with smaller spatial scale.

3CC.4

Photosensitized Reactions of Sulfate Ions in Aerosol Water Form Radical Oxidants, Secondary Brown Carbon, and Organosulfates. ANGELINA PETERSEN, Zonghao Luo, Alair Wong, Ruiyang Xiao, Tran Nguyen, *University of California, Davis*

Sulfate aerosols are ubiquitous in Earth's atmosphere, driving air quality and climate impacts. The liquid water of sulfate aerosols can reach high ionic strength where it was recently shown to promote unexpected photochemical reactivity of the sulfate ions (SO_4^{2-}) under tropospheric radiation. Yet, knowledge of the SO_4^{2-} photochemistry is still insufficient, which hinders fundamental understanding and incorporation into computational models. Our work provides both short (µS) and long (hr) time scale evidence that sulfate ions at the ionic strengths in aerosol liquid water absorb surface-level sunlight and eject electrons, forming reactive sulfate radicals $SO_4^{\bullet-}$. Transient spectroscopy was used to identify $SO_4^{\bullet-}$ radical formation in situ. Quantification of radical production rates was performed by trapping the radicals into organosulfates and analyzing with liquid chromatography coupled to a high-resolution Orbitrap mass spectrometry. We tested compounds emitted from biomass fires, such as 3,4-dimethoxybenzaldehyde, benzaldehyde and p-benzoquinone as well as water-soluble woodsmoke extract, to see if their excited triplet carbon states can photosensitize the $SO_4^{\bullet-}$ production. Our results show increased radical production up to a factor of 5 upon photosensitization, with rates comparable to hydroxyl radical production. In addition to the cloud-activating organosulfates and numerous other products, this photosensitized chemistry also forms light-absorbing secondary brown carbon (sBrC). The relevance of these findings on aerosol oxidant budgets, sulfur cycle reactions, and model representations of aerosol-chemistry-climate interactions will be discussed.

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3CC.5

Continuous Measurements of Gas-Phase Water-Soluble Nitrogen and Carbon During GOTHAAM Reveal Model Biases in Coastal Urban Reactive Nitrogen and Carbon Chemistry.

MADISON LANDI, Amir Babaei-Gharehbagh, Christopher Hennigan, Ellie Smith, Annmarie Carlton, *University of California, Irvine*

Gas-phase polar compounds, including water-soluble nitrogen (WSN_g) and water-soluble organic carbon ($WSOC_g$), contribute to ambient fine particulate matter (PM2.5) through partitioning into atmospheric waters and forming aqueous secondary organic aerosol (aqSOA). Along urban coastlines in the eastern U.S., sea-breeze circulation and recirculation complicate pollutant transport, chemistry, and deposition by mixing anthropogenic and marine air masses. Poor representation of the water solubility and partitioning of reactive compounds in chemical transport models can bias predictions of atmospheric nitrogen and carbon deposition, oxidant chemistry, PM2.5, and ozone (O_3) production. In this work, we present continuous gas-phase measurements of WSN_g, $WSOC_g$, and ammonia (NH_3) at the Flax Pond Marine Laboratory during the GOTHAAM field campaign from 14 July to 20 August, 2025. To our knowledge, these are the first continuous direct measurements of WSN_g. Measurements are compared with predictions from the U.S. EPA's Community Multiscale Air Quality (CMAQv5.3.1) model. WSN_g (mean: 5.98 ppbN) exhibits a pronounced diurnal cycle with maxima in the afternoon to early evening and minima in the morning. This pattern is out of phase with oxides of nitrogen (NO_2, NO, and NO_y), suggesting distinct sources and/or chemical processing pathways. $WSOC_g$ (mean: 7.57 μgCm^{-3}) diurnal profiles exhibit afternoon maxima consistent with secondary photochemistry from VOC oxidation. CMAQ accurately reproduces diurnal profiles of O_3 (r=0.97) and NO_2 (r=0.86) but fails to capture the phase and magnitude of observed WSN_g and $WSOC_g$. These results suggest that the fraction of gas-phase carbon and nitrogen species readily transferred to aerosol liquid water remains poorly represented in CMAQ, potentially biasing predictions of aqSOA formation, reactive nitrogen deposition, and O_3 precursor cycling in coastal urban environments.

3CC.6

The Distinct Multiphase Chemistry of PyroCb Beyond Typical Wildfires.

YUAN LIU, Lu Xu, *Washington University in St. Louis*

Pyrocumulonimbus (PyroCb) events are wildfire-driven deep convective storms that loft smoke directly into the upper troposphere and lower stratosphere (UTLS). However, limited in situ aircraft observations have left the evolution of PyroCb plumes poorly understood and constrained. Here, using FIREX aircraft measurements, we show that PyroCb plume evolution is governed by a sequence of distinct multiphase regimes that differ fundamentally from typical wildfire plumes. Within the deep convective core, intense lightning enhances NO_x, producing anomalously high NO and establishing an unusually NO_x-rich environment. Inside the cloud, abundant liquid water promotes aqueous-phase chemistry, efficiently scavenging highly soluble species and accelerating oxidation. This is evidenced by depleted SO_2, enhanced sulfate formation, and more oxidized organic aerosol. Downstream, cloud-driven VOCs loss combined with enhanced NO_x shifts the plume from NO_x-limited conditions toward a regime favoring rapid O_3 production. Our results demonstrate that PyroCb events are not merely passive vertical chimneys, but also reactive reactors in which fire emissions, deep convection, lightning, and cloud processes collectively reshape the oxidative evolution of wildfire smoke prior to UTLS injection, with important implications for stratospheric composition, radiative forcing, and climate change.

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3IM.1

Advances in Fluorescence Probe Spectroscopy to Characterize Viscosity and Other Physicochemical Properties of Aerosols.
ANGEL GIBBONS, Victoria Cover, Paul Ohno, *Auburn University*

Understanding the viability of viruses contained in respiratory particles and the connections between this viability and the relative humidity (RH)- and temperature-mediated physicochemical properties of the particles themselves is critical to mitigate respiratory disease transmission. Here, we present recent advances in the use of fluorescence probe spectroscopy to investigate the viscosity of aerosols. Viscosity is assessed using molecular rotor probes, such as 4-DASPI, whose fluorescence response depends on the local microviscosity. Three model systems were tested, and the growth media was found to be the most viscous. Furthermore, we demonstrate that volatilization of probe molecules and subsequent condensation into particles of interest is a viable method of aerosol fluorescent labeling. This technique is expected to ultimately enable the study of real exhaled respiratory particles using fluorescence probe spectroscopy.

3IM.2

Advancing Near-Real-Time Aerosol Analysis: Tandem Raman and Elemental Aerosol Spectrometer (TREAS).
ORTHODOXIA ZERVAKI, Kabir Rishi, Dominick Heskett, Wenjin Luo, Bryan Rainwater, Bon Ki Ku, Braden Stump, Pramod Kulkarni, *Centers for Disease Control and Prevention, NIOSH*

We present a second-generation Tandem Raman and Elemental Aerosol Spectrometer (TREAS), an automated near-real time instrument for aerosol chemical speciation and quantification (Analytical Chemistry, 2026, DOI: 10.1021/acs.analchem.5c08252). We describe the design and experimental characterization of the second-generation (Gen-2) TREAS for environmental and occupational aerosol exposure assessment. The first-generation instrument demonstrated the value of automated tandem molecular and elemental analysis; however, its sensitivity was limited by impaction-based collection efficiency, low sampling flow rate, and fluorescence interference during Raman analysis. The Gen-2 TREAS addresses these limitations through four key advancements: (i) replacement of inertial impaction with turbulent-mixing condensational growth and droplet-based aerosol collection; (ii) an order-of-magnitude increase in sampling flow rate to enhance collected mass and detection sensitivity; (iii) reduction of dried aerosol spot diameter to increase analyte surface density; and (iv) implementation of shifted-excitation Raman difference spectroscopy to suppress fluorescence backgrounds in complex aerosol samples. Experimental studies evaluated aerosol collection efficiency, dried spot morphology, and measurement repeatability. Detection limits and near-real-time performance were probed for chemically diverse target species, including amorphous and crystalline silica, carbon nanomaterial polymorphs (e.g. single-walled carbon nanotubes vs. graphene), and selected critical mineral aerosols. Results demonstrate that the enhanced TREAS platform enables more sensitive tandem elemental and molecular aerosol measurements, supporting improved source identification, and chemical speciation of complex aerosols.

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3IM.3

Evaluation of Non-Refractory Chemical Composition on Low-Cost Sensor Performance. SALVATORE MILLETICH, Kyle Aune, Abhirup Datta, Nahin Ferdousi-Rokib, Lei Hao, Misti Zamora, Benjamin A. Nault, Ayreanna Pettijohn, Keelie N. Steiner, Drew Gentner, Benjamin Zaitchik, Peter F. DeCarlo, Kirsten Koehler, *Johns Hopkins University*

Low-cost particulate matter (PM) sensors have become widely deployed in the last decade, filling spatial and temporal gaps in regulatory air quality monitoring. While many studies have developed calibration approaches to correct for systematic biases in these sensors, few have evaluated whether sensor error is dependent on the chemical composition of the aerosol being measured, and whether composition-dependent biases persist after calibration. To evaluate this, we use the SEARCH network, a low-cost sensor network in Baltimore, Maryland, with co-located sensors at regulatory sites and an air-quality supersite within the Baltimore Social-Environmental Collaborative (BSEC). The BSEC supersite hosts a TOF-ACSM-X, along with a SEARCH monitor and weather station, and is located approximately 3.4 km from the regulatory site. Sensor data were calibrated using a two-stage approach, an initial calibration trained on 2019-2023 data was updated using three months of 2024 residuals to account for sensor drift. Three calibration model classes were evaluated: Gaussian mixture regression, random forest, and extreme gradient boosting. Following calibration, separate regression models were used to evaluate associations between sensor error and organic, sulfate, nitrate, ammonium, and chloride mass fractions, while adjusting for temperature, relative humidity, and total non-refractory particulate mass. The evaluation period was from November 2024 through April 2025. Sensitivity analyses restricted to wind-transport time periods between the two sites and stratified by wind-speed tertiles were used to address the spatial offset. Composition error associations varied by fraction but were broadly consistent across calibration approaches. Associations remained statistically significant during low and medium wind conditions but were attenuated at the highest wind speed tertile. These findings indicate that while calibration improves low-cost sensor estimates of PM mass concentration, composition-dependent error may remain. Incorporating aerosol composition into calibration or post-calibration corrections may help reduce residual error and strengthen the use of low-cost sensor networks.

3IM.4

Direct Ambient Black Carbon Monitoring by Photoacoustic Spectroscopy. JOHANNES MURG, Petra Kotnik, Sampsa Martikainen, Herbert Reingruber, *AVL List GmbH, Graz – 8020, Austria*

Black carbon (BC) is an important indicator of combustion-related air pollution from road traffic, industrial activities, and residential heating. It contributes to climate warming due to its strong light absorption [1], and its relevance for air quality assessment has been reinforced by the European Ambient Air Quality Directive (EU) 2024/2881 [2]. Reliable, time-resolved measurements at low ambient concentrations are therefore essential for urban air quality studies, source apportionment, long-term trend analysis, and regulatory monitoring.

Existing ambient BC monitoring technologies are widely used in scientific and regulatory applications, but many established approaches rely on indirect optical measurements and correction procedures to derive aerosol absorption or equivalent BC concentrations. Photoacoustic spectroscopy (PAS), in contrast, provides a direct and filter-free measurement of aerosol light absorption by detecting acoustic waves generated by light-absorbing particles exposed to modulated radiation. Recent instrument-comparison studies further highlight the relevance of robust absorption-based measurement approaches for BC monitoring [3].

Building on long-standing experience with the PAS-based AVL Micro Soot Sensor™ for automotive exhaust applications, AVL has developed the AVL Black Carbon Monitor™ for ambient air monitoring. The instrument was optimized for low-concentration measurements and provides time-resolved BC data in the nanogram-per-cubic-meter range. Its multi-wavelength operation supports characterization of absorbing aerosol components and source apportionment in complex urban environments.

This contribution presents the measurement principle, calibration approach, and key technical features of the AVL Black Carbon Monitor™, including design elements for on-site performance verification during long-term operation. Laboratory benchmark studies with established ambient BC monitoring technologies demonstrated the sensitivity, stability, and suitability of the system for air quality applications. Field measurements at multiple urban monitoring sites in Graz, Austria, showed characteristic diurnal BC patterns associated with traffic activity and spatial differences reflecting local emission influences. These results demonstrate that multi-wavelength PAS is a robust and sensitive approach for direct ambient BC monitoring and urban emission characterization.

References

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3IM.5

Multi-Site Evaluation and Physical Correction of QuantAQ PM2.5 Measurements Using ASCENT Research Grade Measurements. CAN BARUT, David Hagan, Ruizhe Liu, Sohyeon Jeon, Longkun He, Pengfei Liu, Haroula D. Baliaka, Ryan Ward, John Seinfeld, Richard Flagan, Bradley Ries, Erin Bowey, Gino Pena, Yumeng Cui, Roya Bahreini, Mitchell Rogers, Taekyu Joo, Tori Hass-Mitchell, Drew Gentner, Albert Presto, Seonsik Yun, Douglas A. Day, Jose-Luis Jimenez, Nga Lee Ng, *Georgia Institute of Technology*

Low-cost air sensors such as from QuantAQ (MODULAIR-PM and MODULAIR) and PurpleAir sensors are increasingly used to monitor particulate matter (PM) concentrations. However, their performance varies significantly with particle size, composition, and mass concentration—properties that vary across environments. To address this uncertainty, we collocated these sensors with real-time continuous research-grade instruments in the Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT). ASCENT has 12 measurement sites spanning urban and rural environments with diverse aerosol conditions across the U.S. for quantifying aerosol composition, physical properties, and size distributions using Aethalometers (AE33) for black/brown carbon, Xact for trace metal and element analysis, an Aerosol Chemical Speciation Monitor (ACSM) for non-refractory aerosol, and a Scanning Mobility Particle Sizer (SMPS) for real-time particle size distribution measurements. Using measurements from five urban ASCENT sites – Atlanta, Denver, Los Angeles, Pittsburgh, and New York City – we developed a physical correction model for QuantAQ $PM_{2.5}$ measurements. The model first applies a hygroscopicity correction, based on aerosol composition, to account for ambient water uptake. Then it applies a size distribution correction using SMPS measurements to quantify how deviations from calibration aerosol size distributions affect sensor response. The corrected measurements were evaluated by using collocated reference $PM_{2.5}$ monitors and compared with default QuantAQ-reported $PM_{2.5}$ values. We saw variable improvement throughout the sites, while highly humid sites like Atlanta saw a near 40% decrease in RMSE value, dryer sites like Los Angeles saw only 13%. Overall, this work shows that supersites like ASCENT can be used to develop physically interpretable corrections for low-cost optical PM sensors and improve their reliability across diverse atmospheric backgrounds.

3IM.6

Streamlining Laboratory Calibration Methods for PM2.5 Sensors. NAMRATA SHANMUKH PANJI, Xiaobi M. Kuang, Noel Ruiz, Leslie Garcia, Brandon Feenstra, Wilton Mui, *South Coast Air Quality Management District*

The Sensor Library Program offered by the Air Quality Sensor Performance Evaluation Center (AQ-SPEC) program at South Coast Air Quality Management District (South Coast AQMD) aims to expand public access to air quality sensors in the South Coast Basin. Sensors in this program currently undergo calibration via field-based co-location with reference monitors for 1-2 months. This lengthy period for calibration delays sensor loan deployments and consumes sensor lifetime. In addition, sensor calibration models developed from field-based co-location methods may not be transferable to deployment locations and seasons different from that of the co-location. To overcome these challenges, we developed efficient laboratory-based calibration methods for $PM_{2.5}$ sensors to achieve faster calibration turnaround times that may be generalizable across time and space in the South Coast Air Basin. This study included development of an aerosol mixture representative of the Los Angeles area (in terms of particle size distribution, optical properties, and hygroscopicity) which was injected into an environmental chamber to calibrate various models of $PM_{2.5}$ sensors. A suite of experimental designs was carried out to determine a minimal set of environmental conditions on which to base experimental runs for building calibration models: (1) traditional grid matrix (a full factorial design), (2) k-means clusters, (3) Taguchi orthogonal, and (4) Latin hypercube. These sensors were calibrated according to these experimental designs. Meanwhile, a separate cohort of $PM_{2.5}$ sensors was deployed for co-location with reference instruments in the field to build field-based calibration models. We discuss the efficacy of the streamlined laboratory-based $PM_{2.5}$ sensor calibration methods compared to the traditional field-based co-location method.

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3RM.1

From Rain to Reaction: How Moisture Drives Organic Acid Aerosols in a Rural Environment – Measurements from the CoURAGE Campaign at Mt. Airy Baltimore. RAYAL SMITH, Esther Olonimoyo, Jemma Przybocki, Nahin Ferdousi-Rokib, Benjamin A. Nault, Peter F. DeCarlo, Christopher Hennigan, Akua A. Asa-Awuku, *University of Maryland*

Organic acid aerosols are an important component of the regional atmosphere, influencing atmospheric oxidation chemistry and secondary organic aerosol (SOA) formation. These processes have important implications for aerosol–cloud interactions, regional air quality, and climate. This study investigates the abundance, composition, and environmental drivers of water-soluble organic acids in a rural environment using filter-based $PM_{2.5}$ measurements collected in Mount Airy, Maryland, during the Department of Energy Atmospheric Radiation Measurement (ARM) Coastal Urban Rural Atmospheric Gradient (CoURAGE) Experiment from March 19 to June 12, 2025. Mount Airy, located west of the Baltimore metropolitan area, serves as a rural receptor site where measurements capture the influence of transported urban emissions and regional atmospheric processing.

Daily $PM_{2.5}$ filter samples were extracted in ultrapure Millipore water (>18 MΩ·cm) to isolate water-soluble species. The filters are then analyzed using a Waters Acquity I-Class PLUS liquid chromatography system coupled with a Bruker Maxis-II ultra-high-resolution Q-TOF mass spectrometer with electrospray ionization. Thus, enabling sensitive separation and detection of target compounds. Concentrations of fourteen organic acids were quantified, including acetic, propionic, pyruvic, butyric, oxalic, isovaleric, valeric, malonic, maleic, succinic, glutaric, malic, adipic, and citric acids. The cumulative abundance of organic acids followed the order: oxalic (11.3 μg m^{-3} > isovaleric (0.46 μg m^{-3}) > valeric (0.074 μg m^{-3}) > malonic (0.056 μg m^{-3}) ≈ citric (0.053 μg m^{-3}) > butyric (0.033 μg m^{-3}) > propionic (0.021 μg m^{-3}) ≈ succinic (0.022 μg m^{-3}) > glutaric (0.018 μg m^{-3}) > malic (0.013 μg m^{-3}) ≈ pyruvic (0.011 μg m^{-3}) ≈ adipic (0.011 μg m^{-3}) > acetic (0.008 μg m^{-3}) > maleic (0.004 μg m^{-3}). Oxalic acid concentrations are persistent throughout the campaign and 0.5 μg m^{-3} concentrations were measured on 12 of the 35 sampling days of the campaign. Additional analysis indicates that oxalic acid concentrations are elevated during periods of high relative humidity and precipitation, suggesting enhanced aqueous-phase oxidation and secondary formation pathways under humid atmospheric conditions. Organic acids, like oxalic acid have previously been measured in abundance in rural settings. These findings support that aqueous-phase chemistry may play a significant role in shaping rural atmospheric chemistry. These insights have broader implications for both climate modeling and public health.

3RM.2

Chemical Aging of Organic Aerosols in the Atmosphere. CHRISTINA VASILAKOPOULOU, Andreas Aktypis, Angeliki Matrali, Petro Uruci, Kalliopi Petrinoli, Nikolaos Mihalopoulos, Spyros N. Pandis, *University of Patras, Greece*

Organic aerosol (OA) once emitted in the atmosphere undergoes complex chemical and physical transformations which result in its aging. While primary OA from different sources contains little oxygen and is relatively hydrophobic, most of the ambient OA aging from source areas is quite oxygenated with O:C approximately unity. However, the timescales for these transformations remain unclear. Understanding the aging timescales of OA is key to improving chemical transport model, to developing mitigation strategies, and to quantifying the OA impacts on climate. In this study we combine field and modeling results to investigate how fast OA ages in the atmosphere. Using measurements of particle and gas phase in two different sites in Greece (Athens and Poros) and a new iterative method for the estimation of the photochemical age, we investigate how fast OA ages in the atmosphere. Our results show that OA evolves rapidly during just a few hours of transport instead of days, in contrast to what was previously thought. The formation of less oxidized oxygenated organic aerosol (LO-OOA) with an O:C of 0.65 required 6 h in summertime Mediterranean conditions. The conversion of LO-OOA to more oxidized OA (MO-OOA) with O:C=0.93 required 1 d. In order to quantify how much OOA was produced as the air masses traveled from Athens to Poros we combined a trajectory chemical transport model and our measurements as constraints. We estimated that 3.2 μg m^{-3} of LO-OOA were produced on average between the two sites, while the MO-OOA production was 1.7 μg m^{-3}. Concerning primary sources, cooking OA (COA) was transformed into secondary OA much faster than OA from transportation, in contrast to what is expected based on their volatility, showing that heterogeneous reactions are important for COA aging.

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3RM.3

Characterization of Aerosol-Depleted Regions in the Subarctic Ocean. ANKITA MALU, Lintong Cai, Sunandan Mahant, Jefferson Snider, Markus Petters, *University of California, Riverside*

Arctic stratocumulus clouds are known to have two mesoscale structures as closed-cellular and open-cellular. These structures are strongly influenced by aerosols. Prior studies on warm stratocumulus clouds in the Pacific and mixed-phase stratocumulus clouds in the Arctic, have shown a strong correlation between aerosol depletion and open-cellular cloud structure. However, it is still unclear whether low aerosol concentrations cause the transition to open-cellular convection by accelerating drizzle formation, or whether open-cellular convection causes low aerosol concentrations through accelerated aerosol washout. In this study, a case of closed cellular to open-cellular transition within the marine boundary layer during research flight RF04 of the Cold Air Outbreak Experiment in the Sub-Arctic Region (CAESAR campaign) is analyzed. The case was characterized by ultralow aerosol and cloud droplet concentrations, both below than 10 $cm^{-3.}$ The depleted aerosol region was embedded within regions of typical aerosol concentrations (> 200 cm^{-3}). Aerosol size distributions, cloud condensation nuclei, and cloud droplet spectra were compared between the depleted region and its surrounding. Aerosol-to-CCN closure and aerosol-to-cloud-droplet closure was evaluated from the observation. Satellite and model reanalysis data suggest that the region of aerosol depletion was north to a warm air intrusion. This resulted not only in the aerosol depleted region, but also in aerosol gradients on either side of the aerosol-depleted region. Such detailed case-study will help disentangling aerosol, cloud microphysical, and dynamical influences on low-lying Arctic marine clouds, and provide better understanding of aerosol-cloud interaction in the Arctic.

3RM.4

Multi-Platform Evaluation of CMAQ Using TEMPO, ASCENT, and CIMS Observations over Atlanta: Diagnosing Model Biases in Secondary Aerosol Formation. MERVE EKE, Weixin Zhang, Katherine Paredero, Soyoun Gwak, Yongtao Hu, Ruizhe Liu, Sohyeon Jeon, Roya Bahreini, Sean Raffuse, Ann M. Dillner, Greg Huey, Nga Lee Ng, Armistead G. Russell, *Georgia Institute of Technology*

The availability of high temporal resolution datasets, including ASCENT, TEMPO, CIMS, and GOES, provides a unique opportunity to evaluate model performance and investigate the causes of model–measurement discrepancies. Building on previous work, simulations from the CMAQ are compared with TEMPO VCDs and ASCENT ground-level $PM_{2.5}$ speciation measurements at the South DeKalb site, which is located downwind of the Atlanta metropolitan area and influenced by both urban and biogenic emissions. This study extends the analysis from 2024 to the 2024–2025 period and incorporates CIMS observations collected during the summer of 2025 at the same location to better understand gas-phase processes driving secondary aerosol formation. Results indicate that CMAQ captures the general temporal variability but systematically underestimates equivalent black carbon (eBC) and key $PM_{2.5}$ components, including NH_4^+, NO_3^-, SO_4^{2-}, and organics, with larger discrepancies observed for organics and eBC. The modeled sulfate diel cycle differs from observations, particularly during the afternoon, suggesting that primary and near-surface emissions may play a larger role in sulfate formation and accumulation than represented in the model. These differences in sulfate timing and magnitude may also contribute to biases in simulated nitrate concentrations. CMAQ also underestimates nighttime NO while overestimating peroxyacetyl nitrate (PAN), with daytime PAN concentrations approximately twice as high as observed. Although CMAQ reproduces the overall diel patterns of PAN and O_3 across seasons, it shows inconsistencies in the diel behavior of NO and NO_2 compared to observations. These findings suggest that emissions inventories for several species may be underestimated and that current chemical mechanisms may not fully capture key atmospheric processes. This work highlights the value of integrating multi-platform observations to diagnose model deficiencies and improve air quality modeling.

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3RM.5

Global Modeling of Fluorescent Aerosol Particles with Machine Learning Reveals Potential Regional Anthropogenic Impacts. YANHAO MIAO, Patrick K. H. Lee, *City University of Hong Kong*

Primary biological aerosol particles (PBAPs) significantly affect human health and aerosol-cloud-climate interactions. Fluorescent aerosol particles (FAPs), detected using light/laser-induced fluorescence (LIF) instruments, serve as a crucial proxy for understanding the concentration and size distribution of PBAPs and the factors that influence their variability in the atmosphere. This study systematically evaluates FAPs collected from field measurements worldwide and simulates their concentrations on a global scale using machine learning algorithms, incorporating comprehensive global weather, climate and emissions data. The simulated global concentration reveals spatial variations in size and concentration, with heightened annual mean concentration predominantly observed in the tropics and the Asia region. The post-hoc Shapley Additive Explanation (SHAP) method indicates that the spatio-temporal patterns of FAPs concentrations and size distributions are primarily driven by anthropogenic emissions in urban regions, while weather factors are more closely linked to variations in oceanic and rural areas. Notably, certain non-biological emissions (e.g., dust and black carbon) exhibit strong correlations with FAPs, particularly in densely populated areas and the Arctic region. Overall, this study underscores the significant role of anthropogenic emissions in shaping simulated FAP concentrations on a global scale and provides guidance for future investigations into FAP concentrations in unexplored regions.

3RM.6

Molecular Aerosol Composition Within the Atmospheric Boundary Layer at the Southern Great Plains: Seasonal Signatures from Surface to Aloft Revealed by High-Resolution Mass Spectrometry. HAOFEI ZHANG, Gregory W. Vandergrift, Darielle Dexheimer, Sean Murphy, Swarup China, *University of California, Riverside*

Although aerosols within the atmospheric boundary layer (ABL) are generally considered well-mixed, how different transportation mechanisms and chemical processes affect this assumption is unclear, leading to uncertainties in assessing aerosol's impacts on radiative forcing. Here, we present multi-season, vertically resolved molecular characterization of organic aerosol within the ABL at the Southern Great Plains (SGP) user facility. Aerosol samples were collected at the ground level and aloft (100–900 m) via a tethered balloon system (TBS) during winter and summer 2024 and analyzed by nanospray desorption electrospray ionization Orbitrap mass spectrometry. While bulk aerosol elemental properties are largely homogeneous throughout the ABL, individual molecular formula abundances reveal persistent altitude-dependent signatures. Orthogonal Partial Least Squares Discriminant Analysis (OPLS-DA) identified 355–384 ground-enriched formulas per season vs. only 6 aloft-enriched formulas, the latter corresponding to coarse-mode primary biological particles. The ground-enriched formulas are systematically lower in volatility and enriched in organosulfates (3.9× relative to non-discriminatory formulas) compared to the non-enriched formulas. Vertical profiles on individual flight days reveal that the ground enrichment exhibits as a step-function decrease within the lowest ~100 m rather than a gradual mixing gradient. These results suggest that continuous chemical processing near the surface sustains a molecular composition gradient even within a thermodynamically well-mixed ABL. Episodic high-altitude pollutant transportation was also observed to drive vertical gradient of certain molecular formulas. These findings demonstrate that ground-based molecular measurements systematically overrepresent low-volatility, surface-produced species relative to the ABL column composition, with implications for relating ground-based aerosol composition measurements to aerosol-cloud interaction.

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3UA.1

Air Toxic Emission Profiles from Modern Tier II & Tier III Ocean-Going Vessels. KYAH GRACIA, Thomas Eckel, Ryan W. Drover, J. Wayne Miller, David R. Cocker, *University of California, Riverside*

The study investigates the contribution of hazardous air pollutants (HAPs) and other toxics from large ocean-going vessels (OGVs). Samples were taken from tier II and tier III technology class vessels with advanced category III engines. The study serves to quantify the chemical composition and concentration of air toxics from these two technology classes as well as the two regulatory fuel blends containing different sulfur content used in marine transport. A full spectrum of samples were collected at different load points based off the ISO 8178 (E3 & D2) testing cycle and the two fuel types used. Samples were collected from two main engines, the auxiliary engines as well as a boiler for each vessel during voyage at low and high loads. One of the highlights of this body of work are the samples collected at extremely low loads outside of the testing cycle; notably when the emission controls shut off for the vessels operating near the ports. The work shown gives a full chemical analysis of the HAPs and other toxics emitted by both technology classes, including a range along the California coast from the port of Oakland to the port of Long Beach (POLB) as well as the departure from POLB to international waters. This work shows the potential risk and health impact to local portside communities. A full spectrum of species from the engine stack emissions will be shown from aldehydes, ketones, polycyclic aromatic hydrocarbons, metals, and inorganic ions.

3UA.2

Tire Wear Particles as a Source of VOCs: Emissions Under Controlled Laboratory Conditions. VIKAS GOEL, Salahuddin Setu, Talha Jubair, Hosein Foroutan, Gabriel Isaacman-VanWertz, *Virginia Tech*

Tire wear particles (TWPs) are becoming an increasingly important non-exhaust source of traffic related emissions, particularly as vehicle fleets shift toward electrification and urban populations continue to grow. Electric vehicles are generally heavier than comparable internal combustion engine vehicles because of battery mass, which may increase tire-road abrasion and associated TWP emissions. Although TWPs are usually studied as particulate pollution, less is known about the volatile organic compounds (VOCs) released from these particles after they are deposited and dispersed in the environment following emission, and how these compounds change upon exposure to sunlight. In this study, VOC emissions from TWPs generated from five different tires were measured under controlled laboratory conditions. The particles were introduced into an experimental chamber, and gas-phase emissions were measured using a VOCUS proton transfer reaction time-of-flight mass spectrometer. Measurements were conducted under ambient conditions and simulated sunlight to quantify the impact of sun exposure on emission. Detected ions were grouped into chemical families, including hydrocarbons, oxygenated compounds, nitrogen-containing compounds, sulfur-containing compounds, and mixed heteroatom species. Nitrogen- and sulfur-containing compounds were frequently observed, consistent with the presence of tire additives and rubber-related chemical signatures. Emissions profiles were relatively similar across all tires and in all cases emissions generally increased during UV exposure, suggesting enhanced release or formation during photoaging. Oxygenated compounds also changed under UV illumination, indicating that sunlight-driven aging can modify both the composition and volatility of emissions from TWPs. Overall, these results suggest that TWPs should be considered not only as a particulate emission source but also as a source of chemically complex VOCs. Better characterization of these emissions is needed to evaluate their role in urban air quality, atmospheric oxidation chemistry, and secondary organic aerosol formation.

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3UA.3

Tire Derived Chemicals in Particulate Matter in the Near Road Atmosphere. ARTHUR W. H. CHAN, Xing Wang, Alex K.Y. Lee, Colman Wong, Yushan Su, Bonnie Hamilton, Greg J. Evans, Cheol H. Jeong, Hayley Hung, Alexander Kasperkiewicz, *University of Toronto*

Tire wear particles have become an increasingly important source of traffic-related particulate matter as exhaust emissions from internal combustion engine vehicles decline and the relative contribution of non-exhaust emissions increases. Not only does tire wear contribute to total PM mass, the chemicals used during tire manufacturing and their transformation products, collectively known as tire derived chemicals (TDCs) can also be emitted into the atmosphere. Many of the TDCs are of toxic concerns to humans and other organisms, but very little is known about their emissions and processing in the atmosphere.

In this work, we report field observations of TDCs in airborne particulate matter collected adjacent to a major highway in Toronto, Canada. Tire wear particles were quantified through rubber characterization by pyrolysis-gas chromatography mass spectrometry (Py-GC/MS). TDCs are identified by liquid chromatography Orbitrap mass spectrometry (LC-Orbitrap). We found that a large group of TDCs (including antiozonants such as p-phenyldiamines, or PPDs) correlated well with tire rubber, suggesting that tire abrasion as the key emission process. On the other hand, other tire additives, such as dicyclohexylamine, or DCHA, show significantly enhanced concentrations in airborne PM relative to those in tires, especially in smaller particles (PM2.5) and during the summer. Furthermore, the summer/winter ratio of in TDC concentration correlated with the corresponding volatility of the TDC, suggesting a volatilization or partitioning process plays a role in their release. We also observe many compounds that are oxidation products of primary TDCs, pointing to the role of oxidation to producing transformation products, even in the near road environment. Together, these observations highlight the myriad of processes that are involved during the emissions of TDCs into the atmosphere.

3UA.4

Elucidating Year-Round Urban Source Contributions to Fine Particulate Metals at the New York City ASCENT Site. MITCHELL ROGERS, Breanna van Loenen, Lijin Zhang, Tori Hass-Mitchell, Taekyu Joo, Drew Gentner, *Yale University*

With recent reductions in overall fine mode particulate matter ($PM_{2.5}$), particulate metals represent an increasingly important class of pollutants with large spatiotemporal variations, considerable health effects, and sizable uncertainty in source contributions. We leverage a new continuous 2-year dataset of hourly Xact 625i measurements in New York City to resolve the dominant urban sources of metals and evaluate how source dynamics and environmental conditions influence their concentrations. We focus on three major source factors identified via positive matrix factorization: fuel oil combustion, brake wear, and resuspended dust. Fuel oil combustion plumes were linked to a peaker plant unit that ceased operation during the measurement period as well as distributed residential boilers that continue to operate year-round. Fuel oil No. 4 burned at the peaker plant and nearby boilers was responsible for large fractions of many trace metals (e.g., 60-75% of V, Ni, Cr, As, Cd) and sulfur dioxide (≥ 68%) measured at the site. Brake wear metal concentrations were closely related to measured vehicle speeds, increased with ambient temperature, and were correlated with ultrafine particle enhancements during rush hour periods. Resuspended road and soil dust concentrations were dependent on local land use patterns and meteorology, and dust exhibited a larger degree of variability in elemental composition given the multiple dust types that contribute to urban dust, which is examined in this work via rolling regression of dust plumes. The contribution of urban metals sources to air pollution in NYC is evaluated in the context of shifts in energy policies and fuel consumption at the local and state levels.

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3UA.5

Uncounted Industrial Release Events Emissions Increase Estimated Cancer Risk in Houston: A Puff Dispersion Modeling Analysis. ELLIE SMITH, Alexandra Pacheo, Ronald Cohen, Sally Pusede, Annmarie Carlton, *University of California, Irvine*

Industrial facilities use pressure relief devices (PRDs) to mitigate safety risks by venting pollutants during upset and emergency events. These episodic releases are not included in the National Emissions Inventory (NEI), which underpins regulatory air quality modeling (e.g. CMAQ) and cancer risk assessments (e.g. AirToxScreen). As a result, exposures in nearby frontline communities may be systematically underestimated.

Here, we quantify the contribution of PRD release events to ambient pollutant concentrations and cancer risk in Houston, Texas. We develop a hybrid Lagrangian Gaussian puff model representing each release as a series of mass-conserving puffs advected by time-resolved meteorological fields (HRRR) with turbulent diffusion using Pasquill-Gifford stability classes. Fugitive emissions reports from the Texas Commission on Environmental Quality (TCEQ) constrain event timing, duration and mass. Across 163 events comprising 1312 individual contaminant releases in 2023, we find that annual emissions from PRD events at a single facility exceeds 14000 kg of a hazardous air pollutant (HAP) not reported in the 2020 NEI, producing short-lived but spatially extensive concentration enhancements not captured in inventory-based modeling.

Including these events leads to measurable increases in estimated cancer risk based on inhalation unit risk (IUR) values, with the largest impacts occurring in nearby residential frontline communities. Because PRD releases occur near the surface rather than from elevated stacks, their contribution to near-field exposure and cancer risk is disproportionately large relative to their annual reported stack-emitted mass.

To our knowledge, this is the first study to use episodic, near-surface industrial release events to investigate low bias in inventory-based cancer risk estimates. Resolving these previously excluded emissions and their near-field transport facilitates improved quantitative estimates of inhalation exposure and cancer risk and provides a framework transferable to other industrialized regions, including Louisiana's petrochemical corridor.

3UA.6

High-Resolution Hybrid Modeling of Air Toxics over Disadvantaged Communities in Los Angeles. Marc Carreras-Sospedra, Cui Ge, CALVIN HOWES, Jonathan Liu, Rui Zhang, Sang-mi Lee, *South Coast Air Quality Management District*

This study presents a hybrid air quality modeling framework that integrates a regional chemical transport model (CMAQ) with a dispersion model (AERMOD) to characterize community-scale exposure to air toxics in a region in Los Angeles that encompasses two disadvantaged communities. The approach combines CMAQ's capability to simulate regional background concentrations, atmospheric chemistry, and transported pollutants with AERMOD's high-resolution (100-meter) representation of near-source dispersion from facilities and roadways. Emissions inputs were developed using detailed facility data from the South Coast AQMD Annual Emissions Reporting system and on-road activity from SCAG's Regional Transportation Plan processed through EMFAC2021. CMAQ version 5.4 was configured with the Integrated Source Apportionment Method (ISAM) to distinguish local and transported contributions of toxic elements, while AERMOD resolved fine-scale gradients near major roads and industrial corridors. The combined modeling fields were evaluated using measurements from a mobile platform and at fixed sites, showing improved spatial agreement relative to regional modeling alone—particularly for vehicular tracers such as barium and copper and facility-related elements including nickel and lead. Population-weighted exposure analysis further demonstrated that high-emission zones are often spatially separated from densely populated residential areas, highlighting the importance of sub-kilometer modeling to assess local exposure and support environmental justice analyses. While site-specific engineering analysis, computer modeling, and monitoring studies remain the most robust tools for microscale analysis and facility-level regulatory actions, the hybrid AERMOD–CMAQ framework presented here provides the most comprehensive and spatially refined approach to understanding pollutant distributions within urban communities using traditional emissions inventories.

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3UG.1 – INVITED

Heads Up! How to Find Very Tiny Things in the Air with a Large Round Bag That Can Fly High in the Sky. CHONGAI KUANG, Darielle Dexheimer, Casey Longbottom, Carlos Ruiz, *Brookhaven National Laboratory*

Tiny things in the air are important because they can change how sun light moves through the air, and they can help water drop from the sky. To know how much they matter, we need to understand when many new tiny things first form in the air. New work has made a watching-box able to see a single very tiny thing in the air. This lets people watch the first steps of how new tiny things form. Many people have made this kind of study near the ground with a big watching-box, but not many have done this study high in the sky because a big watching-box is heavy and can be hard to lift high in the sky. We need more of this high-in-the-sky study because wind, rain, and how air moves up and down high in the sky may control where and when new tiny things form. To help with this problem, we took a small watching-box with its own power pack and changed it so it could work high in the sky with a large round bag that can fly up and down because the bag has a line to the ground. We also changed the small watching-box so it could now see very tiny things in the air and still be a small watching-box. We will show how the changed small watching-box worked when we used it inside. We will show how it saw big things in the air, and how it saw very tiny things in the air. We will also show how this changed small watching-box worked when we used it outside with a large round bag that can fly high in the sky.

3UG.2

When Do the Tiny Bits in a Forest's Air Grow Larger? Watch Which Way the Wind Blows. CONNOR SETO, Chongai Kuang, Tamanna Subba, James Smith, *University of California, Irvine*

The air is made of little bits that are always changing. These bits are important because they can change how clouds rain or even how hot the sun feels. Too many of them in the air can also make humans sick. So, we study one way that these bits are formed in the air.

To learn about bits forming in new places, groups traveled to a far forest and watched the air. In fact, they're still watching the air right now. This forest's name sounds like two words put together: the place where you go to get money and the part of your body that sits on top. What we found by looking at the air for a long time was that bits often formed in this forest (about one day every week). This is surprising because this has not been noticed in this forest before.

Another group of humans, who study big bodies of water as well as the air, use computers to show which way the wind blew in the past. I will also talk about how we used this to figure out which areas with towns or many trees make smelly air that lead to bits forming.

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3UG.3

Some People in Our State Take in Worse Air than Others with Small Bits from Inside and Outside Their Own Area. LUCAS ROJAS-MENDOZA, *University of California Berkeley*

Some people in our state take in worse air than others, with more small bad bits. To help these people, we need to know what causes this and where the small bits come from. We ran a big computer with many numbers to find out how much of this small bits people in 19 different places take in. We also broke the numbers into 10 kinds of work and looked at whether the small bits came from inside or outside each place. We found that a lot of the small bits come from places that make things and from cars. About 60% of what people take in at these places comes from outside their own area. The causes change from place to place, but growing food, places that make things, cars and home fires are often the most important ones. This means that only cutting what comes from inside each place will not be enough. People in other areas will also need to work together to make things better.

3UG.4

Very Small Matter from Different Trees Icing the Sky. REBECCA CONNER, Ziying Lei, Jack Smith, *University of Tennessee*

Very small matter from different trees plays a big part in forming water and ice in the sky. Some will make the sky cry, and some will make the tears turn to ice. Our study will tell you what types of small tree matter are good at making ice, which push away the light from the sun.

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3UG.5

Small Things Forming and Growing in the Air of Hot Dry Places. KRISTEN CRAMER, James Smith, *University of California, Irvine*

The world warming is bad for everyone but it is very bad for hot, dry places. It can change how hot it is and how much it rains, and these changes can break the systems that animals and flowers need to live. There are small things in the air that are a part of the world's air warming and changing. Some of the small things can make clouds, which can cause even more changes down the line. We study the smallest of these things to learn how they form and grow. We spent over a year in the hot, dry place near us and found a lot of these small things. They appeared most during the summer, and they grew very quickly. This is interesting because we did not expect them to form when it is very hot. We also saw that a lot of bad air made by people travels to the hot, dry place on the wind. If the bad air meets the air from flowers in the hot, dry place and they like each other, they create new air that sticks to the small things and helps them grow. We believe this may be the cause of the small things growing and we are doing more studies in the hot, dry place to discover what the small things are made of. Knowing what they are made of can tell us if we are right about the causes of the small things growing and forming.

3UG.6

Using a Machine That Smells Tiny Hard-to-See Things in Air Where the Sea Meets the Land. TERESA PALACIOS DIAZ, Anna Kapp, Kristen Cramer, Adam Thomas, James Smith, *University of California, Irvine*

The air over land near the sea can have tiny flying things that we cannot see. Even though we cannot see them, they can be made of many different things. Some come from the sea, while others come from land, like cars, trees, and bad things people make.

It is important to understand these tiny hard-to-see air things because they can make people sick. They can also grow into cloud-making things, which can change the Earth and how hot it gets.

We took these tiny things out of the air and grabbed the very smallest ones, the ones hardest to see. We did this for many weeks. Then we brought them back to our school and put them into water and another thing that looked like water.

After that, we used a really cool big machine. The machine turns the tiny things in the water back into flying things, but first it makes them lose something so the machine can smell them. The machine smells the tiny things and tells us what they are made of.

Once we found out what they were, we learned that there are very cool things happening in the air, even inside the tiniest air things, that we did not think could happen.

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3UG.7

What Comes Out When Sky Cars Wake Up Their Fire Boxes and What It Means for the People Who Work Next to Them.
ONYINYE A. EZEIFEKA, Yevgen Nazarenko, *University of Cincinnati*

When big sky cars burn the stuff that makes them go up, very tiny bits come out into the air. These bits are so small that you are not able to see them. But people who work near sky cars take in air with these bits, all day, every day, and that can hurt their bodies over a long time. The world is now thinking about using a new kind of fly stuff that is better for the ground ball. But no one knows yet if this new fly stuff puts out more or fewer tiny bits or if those bits are the kind that go deepest into the body. We burned both kinds of fly stuff the same way a sky car does in our small room and used three boxes to see how many tiny bits came out and how big they were. Most bits were the very smallest kind. The very smallest bits go deepest into the body and can hurt the most. How many came out, and how big they were, changed a lot as the fire burned harder or softer. This work helps keep the people who work near sky cars safe now and as the fly stuff changes.

3UG.8

Big Problems from Small Things: Understanding That Long-Lasting Stuff Doesn't Really Last.
ADAM DEITSCH, D. Orsini, Jie Zhang, Archana Tripathy, Sara Lance, *University at Albany*

People make lots of stuff. Sometimes, we're told it's good, clean stuff—lasting stuff that doesn't break down. We trust that, and we use the stuff a lot. However, it turns out that breaking down does happen. Some long-lasting stuff doesn't really last. Out in the world, under the sun's light, in and around water, or getting very close with other kinds of stuff, this "long-lasting" stuff can change into new or different stuff. It can even change states of matter, usually breaking into smaller bits. The smaller bits can be easier to move through the air, eventually moving to the land and water. We eat it. We drink it. We breathe it in. It is a struggle, for sure. Small things can become big problems. But there are ways to see if some things are present in the air, and those ways can be used to find this stuff we didn't plan on being there. Some ways can even give a close-up look at the make-up of tiny, broken bits to recognize what things are made of. Our group has done this, and we've seen these tiny bits. We're looking at doing this in more places. The plan is to understand as much as we can so we can stop hurting the world and each other.

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3UG.9

How to Get Tiny Bits and Stuff High in the Sky Into Flying Cars Without Losing Them to Crazy Air Problem. NAGARAJAN RADHAKRISHNAN, Charles Brock, Suresh Dhaniyala, *Clarkson University*

Tiny bits and stuff way up high in the sky above us can really change how much world warms or cools. To know what these tiny bits are and where they go, we need to use these big fast flying cars that fly high up in the sky to check them out. But when these big flying cars go very fast and very high up, it is hard to get all the tiny bits inside because the air moves around a lot in crazy ways, gets pushed tight, and keeps changing all the time.

We made an opening track and fixed it to a flying car, where the these bits (both very very small and bigger) comes in safe and at the same time the opening stops the air from moving all over the place.

This opening has two parts. The first part slows the air down and stops the crazy move. The second part gets the tiny bits in the right way. We put this opening on a really fast big flying car, and flew it seven times way way high up in 2025.

This work shows how well it did and what we found out about the air and tiny bits from those times we went up. We also checked how hard the air pushes at many places inside the opening, so we could see if each side is the same as the other side. We put what we saw from each side of the opening next to computer pictures to know if they are right for all kinds of flying.

3UG.10

Understanding How the Brown Drops in Forest Fires Catch the Sun Light. KATELYN PACAUD, Pedro De Allende, Malsha Amugoda, James F. Davies, *University of California, Riverside*

When smoke rises from forest fires, does it look the same up in the sky, and how does it catch the light from the sun? We could catch the smoke in a cup of water and study it, but this changes the picture by watering down these light-catching drops from how they actually are in the air. To avoid this, we study one part of the smoke cloud, a tiny brown drop, along with a tiny clear drop, by holding them under the forces of a machine and pointing a light onto both of them. Using the computer, we then find the size of the brown drop and the number for how much light it catches by looking at it against the light caught by the clear drop. We plan to get the numbers for how much light different kinds of brown drops actually catch without adding extra water, as well as look at how that number changes because of the air around the drop. It is also of interest to study how these small brown drops age, as other matter in the air can meet at the surface of the drop and even enter it, changing the members of the drop and its color. This has been seen before with the tiny water drops above the sea.

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4JS.1

Ph.D. Candidate Seeking Opportunities in the Greater Los Angeles Area. LUCAS ROJAS-MENDOZA, *University of California Berkeley*

I am a Ph.D. candidate in Environmental Engineering at the University of California, Berkeley, expecting to graduate in Fall 2026. My research focuses on developing reduced complexity air quality models using Source Receptor Matrices (ISRMs) to evaluate pollution sources and support evidence based decision making. As part of my doctoral work, I have developed strong computational skills, including programming in Python, working in Linux based high performance computing (HPC) environments, and processing large geospatial datasets from satellite observations and ground based measurements. I have applied these tools to quantify $PM_{2.5}$ exposure across spatial scales in India and within overburdened communities in California.

Prior to my doctoral studies, I spent six years in the mining and metallurgy industry as a process engineer, contributing to two patents and leading teams across operations in the United States and abroad. I also hold a master's degree from Virginia Tech, where I conducted research on diesel particulate matter mitigation in underground mines under a NIOSH funded project. I am fluent in Spanish, conversational in French, currently learning German and bring extensive experience working in international and interdisciplinary settings.

I am seeking full time roles beginning January 2027 in government, national laboratories, industry, think tanks, or environmental nonprofits. My interests include air quality, environmental modeling, sustainability, clean energy transitions, and the mining and minerals sector. I have a strong preference for opportunities based in Los Angeles.

4JS.2

Yanyu Zhang, Ph.D. Candidate, Seeking Postdoctoral Opportunities in Atmospheric Chemistry. YANYU ZHANG, *University of California, Riverside*

I am a fifth-year Ph.D. candidate in the Department of Chemical and Environmental Engineering at the University of California, Riverside, under the supervision of Dr. David R. Cocker III. My research focuses on secondary organic aerosol (SOA) formation through laboratory environmental chamber experiments and atmospheric chemical transport modeling.

My research involves laboratory chamber studies of SOA formation from a range of anthropogenic and biogenic precursors, with emphasis on understanding the effects of oxidation environment and precursor chemistry on aerosol formation pathways. I have extensive experience operating environmental chamber systems and associated gas and aerosol-phase instrumentation, including HR-ToF-AMS, SMPS, APM, and GC-FID, among others, for experimental design, data collection, and analysis. In parallel, I apply SAPRC chemical mechanism modeling and GEOS-Chem modeling—trained respectively under Dr. William P. L. Carter and Dr. William C. Porter—to develop improved predictive representations of SOA formation in atmospheric models, evaluate atmospheric oxidation chemistry, and interpret chamber observations within a broader atmospheric context.

I expect to graduate in December 2026. I am seeking postdoctoral opportunities in atmospheric chemistry and am interested in both laboratory- and modeling-focused positions, particularly those involving aerosol chemistry, atmospheric oxidation processes, air quality, and climate-related research. I welcome opportunities to contribute to interdisciplinary research teams and can be reached at yzhan870@ucr.edu.

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4JS.3

Angel Gibbons Auburn University, Department of Chemistry and Biochemistry, Graduate Student. ANGEL GIBBONS, *Auburn University*

I am a fifth-year Ph.D. candidate in the Department of Chemistry and Biochemistry at Auburn University and a National Science Foundation Graduate Research Fellow. My current research focuses on the development and application of fluorescence-based approaches to characterize the physicochemical properties of respiratory aerosols. Through this work, I investigate aerosol processes relevant to atmospheric chemistry, respiratory particles, and bioaerosol systems, with particular interest in disease mitigation and instrumentation development.

My research experience includes model environmental and respiratory aerosol generation, aerosol characterization using MCPC and SEMS instrumentation, fluorescence spectroscopy, time-correlated single-photon counting (TCSPC), and aerosol particle imaging through confocal microscopy. I also have experience in data analysis, undergraduate and graduate student mentoring, manuscript preparation, and grant writing as evidenced by my strong publication record and success in proposal development.

My broader scientific interests center on understanding aerosol composition, phase behavior, viscosity, and acidity, as well as developing analytical methods that improve characterization of complex aerosol systems. I am especially interested in projects involving bioaerosols, respiratory aerosol chemistry, public health applications, and advanced aerosol instrumentation.

I am seeking opportunities in government labs, or industry related to aerosol science, atmospheric chemistry, analytical chemistry, or instrumentation development. I anticipate graduating within the next year and am open to positions across the United States, with particular interest in collaborative and interdisciplinary research environments.

4JS.4

Ph.D. Candidate Seeking Postdoctoral or Industry Opportunities in Air Quality and Atmospheric Modeling. DEEPSHIKHA OLA, *The Ohio State University*

I am a Ph.D. candidate in the Environmental Science Graduate Program at The Ohio State University and an Environmental Research and Education Foundation (EREF) Fellow, with an expected graduation in 2027. My doctoral research spans two interconnected areas of air quality science. In my first project, I developed a high-resolution near-road emissions modeling framework that integrates MOVES and R-LINE dispersion models to quantify traffic-related pollutant concentrations at fine spatial scales. Building on this framework, I am applying CMAQ to evaluate air quality responses under varying traffic characteristics and emission scenarios at regional scales. In my second project, I am developing a CMAQ-based modeling framework to simulate the atmospheric fate and transport of per- and polyfluoroalkyl substances (PFAS) across Ohio, contributing to the growing body of knowledge on the long-range transport and deposition of these emerging contaminants.

Prior to my doctoral work, I completed a Master's degree focused on aerosol source apportionment using Positive Matrix Factorization (PMF) and Chemical Mass Balance at 12 EPA Chemical Speciation Networking (CSN) sites. My earlier experience as a research assistant after a Bachelor’s degree includes atmospheric sampling and monitoring, laboratory chemical analysis, and characterization of polycyclic aromatic hydrocarbons (PAHs).

My background spans the full arc from field sampling and laboratory analysis to receptor modeling and regional-scale chemical transport modeling. I am seeking postdoctoral, industry, or national laboratory positions across the United States, particularly in air quality modeling, emissions science, PFAS environmental fate, aerosol chemistry, or environmental health.

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4JS.5

Roshan Kumar Singh, Joint PhD Candidate at Civil Engineering at Indian Institute of Technology (IIT) Kanpur and Chemistry, University of Alberta, Seeking a Postdoctoral Position.

ROSHAN KUMAR SINGH, *University of Alberta, Canada and IIT Kanpur, India*

I am a Ph.D. candidate working at the interface of atmospheric chemistry, emissions science, and exposure assessment, with a primary focus on air pollution dynamics across the central Indo-Gangetic Plain (IGP), India. My research integrates field surveys, controlled laboratory experiments, and advanced chemical characterization to quantify both the sources and impacts of particulate and gaseous emissions in rural environments.

I initiated this work through a large-scale household energy survey (~8000 households) to resolve the biomass–energy nexus and associated emission drivers. Building on this, I developed a comprehensive emission factor dataset for 27 region-specific biomass fuels, quantifying a wide spectrum of pollutants including $PM_{2.5}$ and related chemical species, trace gases, and volatile organic compounds. My work further examines the toxicological relevance of emissions through oxidative potential (OP) measurements using DTT and OH-DTT assays, linking OP to chemical composition and combustion characteristics. In parallel, I have investigated the optical properties of biomass-burning aerosols using both offline (EC/OC-based) and online (photoacoustic spectroscopy) approaches, explicitly quantifying methodological uncertainties. I have also contributed to emission inventory development and health impact assessment, estimating morbidity and mortality associated with six major agricultural activities, including crop residue burning.

Complementing my academic training, my upbringing in a rural agricultural setting, with direct experience in livestock management and cropland practices, provides a grounded understanding of rural socio-economic systems and uniquely motivates my research in these environments.

Currently supervised by Prof. Ran Zhao (University of Alberta) and Prof. Tarun Gupta (IIT Kanpur), I have extensive experience with advanced analytical instrumentation (EC-OC analyzer, IC, GC-MS, HPLC, SEMS, trace gas analyzers, ED-XRF, ICP-MS). I seek postdoctoral opportunities starting in Summer 2027 in atmospheric science, emissions, or air quality research, and am open to international positions. My long-term goal is to contribute to academia through research and teaching in air pollution science.

4JS.6

Kyah Gracia, Ph.D. Candidate Seeking Government or Industry Roles in Air Quality and Environmental Engineering.

KYAH GRACIA, *University of California, Riverside*

I am a fourth-year Ph.D. candidate in the Department of Chemical and Environmental Engineering at the University of California, Riverside, working under the supervision of Dr. David R. Cocker III. Prior to my Ph.D. I received a B.S. in Chemical Engineering which has strengthened my interdisciplinary approach to atmospheric chemistry. My research focuses on primary organic aerosols (POA), inorganic species and other air toxics emitted from both mobile sources, including small off-road engines and ocean-going vessels, as well as stationary sources such as roadway and asphalt emissions.

My work centers primarily on maritime emissions, with an emphasis on identifying and characterizing unregulated toxic compounds present in engine emission profiles. Through this research, I apply advanced analytical techniques to evaluate complex chemical mixtures and assess their potential environmental and community health impacts. I use a wide range of instrumentation, including an OC/EC analyzer, gas chromatographs equipped with Gerstel thermal desorption systems (TDS) and mass spectrometry (GC-MS), ion chromatography (IC), high-performance liquid chromatography (HPLC), X-ray fluorescence (XRF), and a Horiba 5-gas analyzer to develop comprehensive chemical characterizations of emission profiles. These analyses allow me to evaluate both environmental impacts and potential public health impacts associated with real-world emissions.

I have experience in designing complex test plans on live emission sources for high resolution batch composition analysis; additionally in high frequency activity data sets. This has allowed me to manage year(s) long sampling campaigns for both the field test side as well as analytical method development and data output flow. I also have experience designing a multitude of sampling systems used in field campaigns for maritime and shoreside research. My work has given me experience determining relevant data to gather from real world operations in order to contextualize field samples taken in situ to be representative to larger population sizes. I also have experience in the materials side of designing and testing emissions control technology (catalyst) for small engine types.

My expected graduation date is June 2027. I am seeking work in government or private industry related to air quality, emissions, environmental regulation, or applied research and development in materials. I am looking for a job that involves field work in addition to laboratory. I enjoy the technical and hands-on nature of my research. I would like to work and collaborate in an interdisciplinary environment. I am open to relocation for the right opportunity.

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4JS.7

Zhuoying Lin, PhD Student at UCLA, Environmental/Sustainability Consulting. ZHUOYING LIN, *University of California, Los Angeles*

I am a PhD student researcher with interdisciplinary experience in atmospheric and materials chemistry. My current research focuses on the measurement and characterization of transportation-related $PM_{2.5}$ emissions to evaluate their spatial variability and potential toxicity across the Los Angeles region. My previous work involved optimizing the performance of lithium–sulfur batteries. My broader interests include environmental regulatory compliance, sustainability, and policy development toward a more sustainable future. I anticipate being available for full-time positions beginning in Summer 2027. I am interested in project-based research roles within government agencies and environmental consulting firms. I am open to opportunities throughout the United States, with a preference for positions located in California or along the West Coast. Remote or hybrid opportunities are also of interest.

4JS.8

Colleen Miller, Ph.D. Candidate Seeking Government, Industry, or Nonprofit Opportunities in Air Quality, Clean Energy, or Sustainability. COLLEEN MILLER, *University of California, Irvine*

I am a fifth year Ph.D. Candidate in the Chemistry Department at the University of California, Irvine, with an expected graduation in June 2027. My thesis work is focused on improving our understanding of acid-base nanoclusters through analysis of their composition and stability in order to hypothesize how these nanoclusters may be growing and interacting with one another in real-world conditions.

In order to study these nanoclusters, I took part in a method development project where we integrated a bipolar electrospray, half-mini differential mobility analyzer, a faraday cup electrometer, and an Orbitrap mass spectrometer (Orbitrap MS) for a novel instrumentation suite which allowed for determining size-resolved composition of nanoclusters as well as fragmentation studies to elucidate nanocluster stability and breakdown pathways. Through this method I have studied both methanesulfonic acid - amine and sulfuric acid – amine systems.

Through my current and past work I have developed familiarity with Orbitrap MS, thermal desorption chemical ionization mass spectrometry (TD-CIMS), atmospheric pressure interface-time-of-flight mass spectrometry (APi-TOF MS), high performance liquid chromatography (HPLC), hydrogen and carbon NMR, and cyclic voltammetry analysis. In my undergraduate work at the University of Washington, Bothell, I operated a gas chromatography instrument during a field campaign for the detection of peroxyacetyl nitrate from wildfire emissions as well as spearheaded a data analysis project on low-cost PurpleAir sensors where we determined calibration factors needed to correct for different pollution types the sensors measure.

I am interested in bridging the gap between scientific research and its use in real-world communities and have had experience preparing a policy brief, advocacy campaign, and community engaged research that may be used in local Southern California communities. Additionally, I have been a part of many science outreach activities, working to encourage young students to get involved in science – both in their everyday world and as possible careers.

I am seeking opportunities in government, industry, or nonprofits where air quality, environmental chemistry, clean energy, or sustainability research is forefront. I have a strong preference to becoming involved in science advocacy work that melds research and working with communities.

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4JS.9

Adam Deitsch, Atmospheric Science PhD Candidate, Seeking a Research Scientist Position in Academia, Government or Industry. ADAM DEITSCH, *University at Albany*

I am a PhD Candidate at the University at Albany Atmospheric Sciences Research Center (ASRC) under the guidance of Dr. Sara Lance, expected to graduate in 2027. My graduate research focuses on persistent pollutants—more specifically, atmospheric micro/nanoplastics and per/polyfluoroalkyl substances (PFAS) in cloud water and precipitation samples, and ambient air, which involves the study of atmospheric chemistry, aerosols, air quality, and the transport and deposition of environmentally relevant compounds.

Research projects I've participated in during my time at UAlbany, as an NCAS-M Graduate Fellow, and as an intern at the NOAA Global Monitoring Laboratory, have provided me experience with various experimental techniques and datasets, including filter-based sampling methods, novel use of an Aerodyne High-Resolution Time-of-Flight Aerosol Mass Spectrometer to chemically characterize nanoplastic aerosols, and intensive use of a TSI Scanning Mobility Particle Sizer for characterizing airborne particle size distributions. I've developed analytical skills using IGOR Pro, HYSPLIT, Python, and R.

I've also gained teaching and communication experience as a Graduate Teaching Assistant, substitute lecturer, and guest lecturer in the UAlbany Department of Atmospheric and Environmental Sciences, and as a presenter at multiple national conferences, e.g., American Association for Aerosol Research (AAAR), American Meteorological Society (AMS), and National Atmospheric Deposition Program. Presentations at AAAR (2025) and AMS (2023) have been recognized as award-winning work. As public accessibility of knowledge is important to me, I have also volunteered for scientific outreach, e.g., presenting at the ASRC Falconer Lecture Series, assisting with high-school summer science camps, and making science communication videos on YouTube.

I am looking to work as a research scientist in academia, government, or industry. While my current aim is to continue pursuing research on indoor and outdoor air quality, I am also excited about exploring other opportunities and topics in atmospheric, climate, and environmental sciences.

4JS.10

Kevin K. Crown, Ph.D. Seeking Research Scientist, Principal Investigator, or Technical Leadership Opportunities. KEVIN K. CROWN, *National Strategic Research Institute*

My research focuses on aerosol science, bioaerosol sampling, environmental biosurveillance, microbiology, molecular biology, and biodefense. I recently earned my PhD in Biological Defense and Health Security from the University of Nebraska Medical Center, my dissertation centering on the development of nanofibrous water-soluble collectors used in bioaerosol and surface sampling for microbial detection. My work has resulted in peer reviewed publications, provisional patents, and technologies designed to improve environmental sampling, pathogen recovery, and biological threat detection. As a Senior Scientist with the National Strategic Research Institute, I lead research involving bioaerosol generation and characterization, electrospinning, qPCR assay development, bioaerosol collection, environmental surveillance, and high containment laboratory operations. My experience spans decades in supporting government sponsored biodefense programs including research at Sandia National Laboratories and at the University of Nebraska. Multidisiplinary collaborations that integrate biology, aerosol science, engineering, and technology development, used to address national security and public health challenges, as been the standard in my career to this point. I am available immediately for full time positions and am seeking opportunities as a Research Scientist, Principal Investigator, Technical Lead, or Program Manager within academia, government, national laboratories, or industry. My long term goal interests include leading innovative research programs, developing externally funded collaborations, mentoring scientists and students, and translating emerging technologies into operational capabilities. While I am currently based in Nebraska, I am open to opportunities nationwide for the right position.

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4JS.11

Muhammad Isa Abdurrahman, PhD Candidate Seeking Research Scientist/Postdoctoral Positions in Aerosol Science.

MUHAMMAD ABDURRAHMAN, *University of Georgia*

I am pursuing a PhD in civil and environmental engineering at the University of Georgia. My research is focused on using experimental and fundamental approaches to provide a better understanding of the sources of variability in the physicochemical properties of atmospheric emissions. My PhD work has equipped me with substantial experience in conceptualizing, designing, and setting up experimental systems to analyze various physicochemical properties of wildland fire emissions, including reactive nitrogen and the formation and atmospheric evolution of primary and secondary organic aerosol, including their chemical composition and light-absorption properties. This research work has been the backbone of my 16 publications, including the four papers that make up my dissertation.

During the four years of my PhD, I have acquired ample experience in operating and troubleshooting several quantitative and mass spectrometric instruments, including a high-resolution soot particle aerosol mass spectrometer (SP-AMS), an oxidation flow reactor (OFR), a smog chamber, a scanning mobility particle sizer (SMPS), a photo-acoustic spectrometer, a UV-Vis spectrometer, an AROMA-VOC analyzer, trace gas analyzers, and others. I routinely calibrate, operate, troubleshoot, and analyze data from these instruments. I have also deployed several of them during the Georgia Wildland Fire Simulation experiments (G-WISE) campaign, a large-scale multi-institutional collaborative campaign focused on characterizing the physicochemical properties of smoke aerosol produced from wildland fires.

The two-month G-WISE campaign has been a vital learning opportunity, especially in aspects of collaborative research and project leadership. I helped coordinate the campaign and managed scheduling, experimental execution, and communication while also actively contributing to measurements.

I am seeking postdoctoral fellow or research scientist opportunities in emissions characterization and air-quality research. I expect to graduate in December 2026 and will be available to begin the appointment immediately thereafter. I am open to positions throughout the continental United States.

4JS.12

Nagendra Raparthi, Postdoctoral Fellow Seeking Faculty/Research Scientist Positions in Aerosol Science.

NAGENDRA RAPARTHI, *University of California, Davis*

My research journey began with a simple question: how do the particles we breathe form, evolve, and affect our health and climate? During my Ph.D. and postdoctoral work at IIT Bombay, I answered part of this question at the source, quantifying real-world vehicle emission factors and the oxidative potential of traffic-derived particulate matter, connecting what comes out of a tailpipe to its downstream impact on human health. That question led me further, from emission sources to atmospheric fate. As a postdoctoral fellow at the Air Quality Research Center, UC Davis, I now study how organic aerosols absorb water and form cloud droplets, a process central to climate. To probe this, I developed a novel methodology to measure hygroscopicity and chemical composition from the very same aerosol filter sample, at near-saturation conditions. Building on this, I established a new framework using thermodynamic models to predict the hygroscopicity of ambient particles directly from their functional group composition, closing the loop between molecular structure and climate behavior. Across this journey, I have built expertise spanning field instrumentation, analytical chemistry, and thermodynamic modeling, always in pursuit of one goal: connecting molecules to climate and health outcomes. As I near the end of my postdoctoral appointment, I am excited to bring this expertise to a faculty or research scientist role in aerosol science, atmospheric chemistry, or air quality research, with availability beginning early-mid 2027. I welcome opportunities across academia, national laboratories, or government institutions, and remain open to any location. I look forward to connecting with colleagues who share this passion for understanding aerosols across scales at AAAR 2026.

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4JS.13

Yanhao Miao, Ph.D. Student in Atmospheric Chemistry, Seeking a Postdoctoral Position in Bioaerosol Measurement, Indoor Air Quality, and Artificial Intelligence for Aerosol Science. YANHAO MIAO, *City University of Hong Kong*

Biological particles make up a large share of ambient aerosol, yet they remain hard to measure in real time and harder still to predict. My dissertation addresses both problems, and the methods travel well beyond bioaerosol research.

Measurement: using real-time fluorescence instrumentation, DNA sequencing, and chemical speciation, I built multi-year records of bioaerosol concentration and composition in subtropical Hong Kong, covering outdoor air and mechanically ventilated indoor spaces. These measurements show that seasonal bioaerosol dynamics track anthropogenic activity rather than meteorology alone, which complicates the common assumption that primary biological aerosol is largely natural in origin.

Prediction: I trained machine learning models that infer indoor bioaerosol concentrations from low-cost air quality sensor data, replacing instrumentation that most buildings will never have. That work forms the basis of a U.S. patent application. I have since scaled the approach globally to map fluorescent aerosol particles and distinguish regional anthropogenic signals from background.

Earlier projects built broader footing in aerosol chemistry: metal solubility in urban PM2.5, phthalate esters in landfill PM2.5, and source apportionment using PMF and HYSPLIT.

I am looking for a postdoctoral position where bioaerosol measurement meets data-driven modeling. I am equally drawn to adjacent problems, including the composition of wildfire smoke, bioaerosols as ice nucleating particles, and airborne pathogen detection paired with building-scale interventions. I bring experience with field campaigns, real-time optical instrument deployment and troubleshooting, offline chemical and biological characterization, and Python and R.

Anticipated availability: Ph.D. expected December 2026; available January 2027.
Positions of interest: academic postdoc (primary); national laboratory or government research; industry R&D.
Geographic preference: open to any location in the United States.

4JS.14

Bradley H. Isenor, PhD Candidate, Seeking Postdoctoral Positions. BRADLEY H. ISENOR, *University of Toronto*

I am an environmental chemist specializing in the toxicity of wildfire and urban fire smoke. My work focuses on understanding how the composition and oxidative potential of combustion derived $PM_{2.5}$ is modified by burning different fuels under different conditions and what role oxidative aging may play as it is transported. I am supervised by Prof. Arthur Chan, at the University of Toronto, and expect to graduate in September 2027.

My interest in aerosol began during my undergraduate research with Prof. Jenny P.S. Wong at Mount Allison University. Here, I investigated how fuel type and cookstove design influence the oxidative potential and exposure to $PM_{2.5}$. This work produced an honours thesis and a publication.

Since starting my doctoral studies at the University of Toronto, my research has spanned three complimentary projects. First, I used the dithiothreitol assay to characterize how severe wildfire smoke impacted the oxidative potential (OP^{DTT}) at 3 sites across North America in 2023, Canada's worst year of wildfires. Next, I worked on the 2024 Biomass Burning in Canada fire-lab campaign, where in collaboration with other academic and government researchers, we made measurements of the gas- and particle-phase emissions from burning boreal forest and anthropogenic fuels using a comprehensive suite of instruments. I operated an iodide-CIMS and conducted filter-based analysis of OP^{DTT}, environmentally persistent free radicals (EPFR), and reactive oxygen species (ROS). Most recently, I am investigating how simulated photooxidative aging modifies the composition, OP^{DTT}, EPFR, and ROS profiles of $PM_{2.5}$ from plastic combustion to gain insight to how smoke from wildland urban interface fires change as they are transported.

I am seeking a postdoctoral position in North America or Europe where I can apply and extend my expertise to new problems in atmospheric chemistry, air quality, or environmental analytical science more broadly.

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4JS.15

Amir Babaei Gharehbagh, Ph.D. Candidate in Environmental Engineering and Research Scientist. AMIR BABAEI-GHAREHBAGH, *University of Maryland, Baltimore County*

I am a Ph.D. candidate in Environmental Engineering at the University of Maryland, Baltimore County (UMBC), with an expected graduation in Summer/Fall 2027. My research focuses on understanding the environmental fate and transport of atmospheric pollutants and emerging contaminants through laboratory experimentation, field measurements, and quantitative data analysis. My current work investigates the physicochemical behavior of per- and polyfluoroalkyl substances (PFAS), while my broader research interests include atmospheric chemistry, air quality, and environmental processes that govern the partitioning and transformation of contaminants.

My research combines experimental measurements with data analysis to improve the understanding of complex environmental systems. I have experience with analytical instrumentation, environmental sampling, experimental design, statistical analysis, and the interpretation of environmental datasets. I routinely use Python, together with modern AI-assisted programming tools, to automate data analysis, perform model fitting, and produce publication-quality scientific figures and visualizations.

Prior to pursuing my Ph.D., I worked for approximately ten years as a chemical engineer in the wastewater treatment industry, gaining practical experience in process engineering, operations, troubleshooting, and project execution. This industrial background, combined with my doctoral research, has equipped me with a multidisciplinary perspective for addressing environmental challenges through both engineering and scientific approaches.

I am seeking an industry internship for Summer 2027 and a full-time research or engineering position beginning in Fall 2027. I am particularly interested in opportunities related to atmospheric chemistry, air quality, environmental fate and transport of contaminants, and analytical environmental science.

4JS.16

Satoko Kayaba, JSPS Postdoctoral Fellow, Seeking a Postdoctoral Position in Aerosol Oxidative Potential and Air Quality Modeling. SATOKO KAYABA, *National Institute for Environmental Studies*

I am a Japan Society for the Promotion of Science (JSPS) Postdoctoral Fellow at the National Institute for Environmental Studies (NIES) and I earned my Ph.D. in 2024. I develop atmospheric and kinetic models to connect atmospheric chemistry with oxidative-stress-related health impacts.

In my doctoral research, I used a regional chemical transport model (CTM) to evaluate how future energy and transportation transitions in Japan would affect ozone and water-soluble metals in $PM_{2.5}$. I developed future emission scenarios and inventories, and conducted sensitivity simulations. I continue to extend the CTM by implementing several multiphase reactions and evaluating their effects on the model performance in simulating O_3, total reactive nitrogen (NO_y), and aerosols.

As a postdoctoral researcher, I developed a kinetic–equilibrium box model for the dithiothreitol (DTT) assay to mechanistically reproduce synergistic and antagonistic effects of organic ligands on Fe-mediated oxidative potential (OP). The model explicitly represents Fe redox cycling, reactive oxygen species (ROS) production, DTT consumption, and Fe–organic complexation, including the effects of complexation on redox potentials and reaction kinetics.

This framework advances the interpretation of mixture effects in aerosol oxidative potential, which are difficult to isolate experimentally. I am now extending this work by coupling in silico OP modeling with a three-dimensional CTM to assess aerosol OP at regional scales.

My expertise includes CTM utilization and extension, kinetic and equilibrium modeling of aerosol OP, emission scenario, model–measurement evaluation, Fortran programming.

I am seeking postdoctoral opportunities beginning in April 2027 in aerosol oxidative potential, air quality modeling, or air pollution and health. I am geographically flexible and open to positions worldwide. I can be reached at kayaba.satoko@nies.go.jp

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4JS.17

Shu-Wen You, Ph.D. Candidate, Washington University in St. Louis, Seeking Postdoctoral Positions in Aerosol Chemistry and Physics. SHU-WEN YOU, *Washington University in St. Louis*

I am a fifth-year Ph.D. candidate working with Prof. Rajan Chakrabarty at Washington University in St. Louis. My research integrates laboratory experiments and airborne measurements to investigate the physicochemical and optical properties of atmospheric aerosols, with an emphasis on constraining the direct and indirect radiative effects of wildfire smoke.

My primary research focuses on dark brown carbon (d-BrC), a strongly light-absorbing component of wildfire smoke. I established a laboratory method for synthesizing and characterizing wildfire-like d-BrC aerosols and investigated their resistance to photobleaching, hygroscopic properties, and ice-nucleating ability. In summer 2026, I led airborne measurements of the physicochemical and optical properties of BrC in pyrocumulonimbus smoke during the INjected Smoke and PYRocumulonimbus Experiment (INSPYRE) over the northwestern US. My responsibilities included designing and integrating aerosol instrumentation, developing the sampling strategy and in-flight operating procedures, and coordinating measurements of fresh, aged, and upper-tropospheric and lower-stratospheric smoke. I also led the drafting of an NSF proposal related to INSPYRE, further developing my experience in research planning and scientific grant writing.

Beyond my primary research, I have contributed to interdisciplinary projects addressing the climatic and health effects of aerosols, bioaerosol sampling and detection, soot toxicity, and the heterogeneous chemistry of candidate particles for stratospheric aerosol injection. These collaborations have provided me with broad experience in aerosol generation, environmental chamber experiments, field measurements, and instrument integration.

My doctoral research has produced three first-authored and seven co-authored papers and manuscripts, including work that is published, under review, or in preparation. I anticipate completing my Ph.D. in July 2027 and am seeking postdoctoral opportunities in the United States or Europe involving aerosol chemistry and physics, atmospheric measurements, aerosol–cloud interactions, or the climatic and health effects of aerosols.

4JS.18

Sijia (Lucia) Liu, Ph.D. Candidate in Chemistry and Aspiring Atmospheric Aerosol Research Scientist/Postdoctoral Researcher. SIJIA LIU, *University of California, Irvine*

I am a Ph.D. candidate in Chemistry at the University of California, Irvine, specializing in atmospheric aerosol chemistry. My research examines how molecular composition, environmental conditions, and atmospheric processing control the formation and physicochemical properties of secondary organic aerosol (SOA). I combine laboratory chamber experiments, field measurements, advanced chemical characterization, and collaborative modeling to investigate aerosol formation across scales.

My laboratory research has focused on SOA produced from the oxidation of biogenic volatile organic compounds, including cyclic and acyclic monoterpenes, sesquiterpenes, and precursor mixtures. This work has evaluated how molecular structure and chemical interactions influence SOA yields, volatility, viscosity, evaporation, morphology, and molecular composition. My current research also investigates indoor aerosol formation from volatile chemical products, with emphasis on new particle formation, oxidation chemistry, ventilation, and the competing effects of air exchange on pollutant removal and oxidant resupply.

In field research, I have used unmanned aerial system measurements to characterize the vertical and horizontal heterogeneity of aerosol composition near boundary-layer clouds over a southeastern U.S. forest. My broader expertise includes aerosol mass spectrometry, high-resolution molecular analysis, particle sizing, electron and X-ray microscopy, single-particle characterization, experimental design, quantitative data analysis, and interdisciplinary collaboration.

I anticipate completing my Ph.D. and becoming available for employment within the next year. I am seeking academic postdoctoral, government or national laboratory, and industry research scientist positions related to atmospheric aerosols, air quality, environmental chemistry, or climate-relevant particle processes. I am geographically flexible and open to opportunities across the United States.

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4JS.19

Jackson Ryan, Atmospheric Chemistry PhD Candidate, Seeking Postdoctoral and Other Opportunities in the Southern California Area. JACKSON RYAN, *University of California, Irvine*

My graduate research centers on the role of trees in urban environments as both sources and sinks of secondary organic pollutants. I have developed and deployed an automated cartridge sampler, collecting hundreds of VOC samples in downtown Los Angeles across various seasonal and temporal periods to evaluate and differentiate between anthropogenic and biogenic VOC sources. Additionally, I have conducted experiments assessing how different tree species uptake organic and inorganic atmospheric particles, am working to parametrize these results to improve current atmospheric chemistry models. I possess proficiency in Python and R programming, and I am experienced in the routine operation and maintenance of thermal desorption gas chromatography-mass spectrometry. My research interests include atmospheric chemistry, air quality, and the intersection of chemical processes affecting diverse environments. I anticipate defending my thesis in December 2026 and am seeking employment starting January or February 2027. I am open to postdoctoral opportunities, industry roles in air quality or atmospheric instrumentation, and government opportunities in air quality management. My ultimate goal is to continue contributing to scientific research in atmospheric sciences. Due to familial obligations, I am primarily seeking opportunities within the greater Southern California area or remote positions.

4JS.20

Michael Lum - 6th-Year Ph.D. Candidate - Seeking Research Related Positions. MICHAEL LUM, *University of California, Riverside*

My name is Michael Lum, a 6th year Graduate Student currently studying atmospheric chemistry at the University of California, Riverside and I anticipate graduation in Spring of 2027. My thesis has focused on the unique behavior of group 16 heteroatom (S, Se) containing VOCs, categorization and impacts of their oxidation products.

My research projects have utilized a large variety of analytical instrumentation including a filter inlet for gases and aerosols time of flight chemical ionization mass spectrometer (FIGAERO ToF-CIMS), a mini aerosol mass spectrometer (mAMS), several types of liquid chromatography mass spectrometry (LCMS), an ion chromatography system (IC), an electron paramagnetic resonance spectrometer (EPR), and an x-ray photoelectron spectrometer (XPS). My first project (ACS EST Air 2024, 1, 12, 1637–1649) utilized CIMS and LCMS for molecular-level identification of major oxidation products resulting from nighttime oxidation of thiophene, while utilizing a novel methodology using mAMS to deconvolute the sulfate signal into contributions from organosulfates, sulfonates, and inorganic sulfate. My second project (Environ. Sci. Technol. 2026, 60, 7, 5608–5618) investigated selenium's ability to generate reactive oxygenated species (ROS) through Fenton-like redox reactions after aerosol deposition into aqueous environments while defining conditions necessary for elevated ROS production compared to analogous sulfurous products. My final project centers on gaining insights into the photooxidation mechanism of dimethyl diselenide by comparing its oxidation products with those of dimethyl disulfide and dimethyl selenide. Throughout my projects I have gained the skills necessary to monitor and identify resulting gas phase products as well as those that partition into the particle phase, using a variety of on-line and off-line techniques. I hope to continue to utilize my expertise in gas and aerosol phase chemistry and analytical techniques within the track of scientific research careers related to air pollution, atmospheric chemistry, and climate change.

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4JS.21

Regina Luu, PhD Candidate in Atmospheric Chemistry, Seeking: Industry or Government positions in Southern California. REGINA LUU, *University of California, Irvine*

I am a Ph.D. candidate in Atmospheric Chemistry with expertise in atmospheric modeling, air quality, and scientific computing. My research focuses on using numerical models and large environmental datasets to investigate atmospheric processes, evaluate model performance, and understand the interactions between chemistry and the climate. Through my doctoral research, I have developed strong quantitative skills in data analysis, statistical interpretation, scientific programming, and communicating complex scientific findings to diverse audiences. My technical experience includes numerical modeling, data visualization, scientific computing, and analysis of large datasets. In addition to research, I have experience teaching and mentoring undergraduate students, developing strong communication and collaboration skills.

I am seeking full-time positions beginning in July 2027 in research, quantitative analysis, climate risk, data science, atmospheric modeling, or related fields. I am interested in opportunities that leverage Earth system models, large-scale environmental datasets, machine learning, or predictive modeling to address challenges in climate, energy, sustainability, or financial risk.

I am excited to connect with employers in climate technology, environmental consulting, quantitative analytics, financial services, and other industries seeking scientists who can transform complex environmental data into practical solutions. I am open to opportunities throughout the United States, with a preference for hybrid or remote work arrangements.

4JS.22

Prabhav Upadhyay — Ph.D. Candidate in Environmental Science & Engineering (Washington University in St. Louis) | Aerosol Optics, Instrumentation & Light-Scattering Modeling. PRABHAV UPADHYAY, *Washington University in St. Louis*

I am a Ph.D. candidate at Washington University in St. Louis, advised by Prof. Rajan Chakrabarty, specializing in aerosol optics — instrumentation, experiments, and modeling — with a focus on stratospheric aerosol injection (SAI) and the atmospheric impacts.

My expertise spans experimental aerosol optics and instrumentation: I design, build, and calibrate photoacoustic spectrometers and complementary optical systems for wavelength-dependent measurements of aerosols. My hands-on experience covers the full instrument workflow — optical alignment, laser and detector integration, instrument automation, uncertainty analysis, and aerosol generation — and includes COMSOL Multiphysics modeling of acoustic resonator design to improve photoacoustic detection sensitivity. I pair these measurements with T-matrix and electromagnetic scattering calculations to quantify how aggregation, monomer arrangement, and complex morphology alter optical properties — directly relevant to SAI, where injected particles may aggregate, transform, or acquire coatings that change their radiative efficiency and lifetime. My current work, characterizing partially oxidized Al aerosols released during satellite re-entry, and their effects on stratospheric heating and ozone, is in preparation for publication.

My contributions extend beyond first-author work; I have supported colleagues' research through co-authorship, shared instrumentation expertise, and mentorship of junior lab members in experimental aerosol methods.

I am seeking postdoctoral positions in academia, government, or national laboratories focused on experimental aerosol science, aerosol optics, atmospheric instrumentation, SAI, radiative effects, or stratospheric chemistry.

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4JS.24

Kieudiem (Kate) Nguyen, PhD Candidate in Atmospheric Chemistry, Seeking Government or Industry Positions in Air Quality Modeling and Environmental Data Science. KIEUDIEM NGUYEN, *University of California, Irvine*

I am a Ph.D. candidate in Atmospheric Chemistry, expecting to graduate in June 2027. My research focuses on developing and applying kinetic models to understand nanocluster aerosol formation and particle evolution in indoor environments. I also collaborate with experimentalists on flow tube studies to characterize indoor pollutants around occupants to support human exposure assessments. My research work integrates mechanistic modeling, data analysis, and lab experiments to investigate aerosol formation and growth under indoor conditions.

I am seeking full-time positions beginning in Fall 2027 where I can continue applying modeling and data analysis to complex environmental systems and translate scientific findings into actionable insights. My experience includes developing process models, analyzing large datasets, and applying machine learning to environmental problems. I am interested in roles involving air quality modeling, environmental data science, or other opportunities where modeling and data analysis can improve our understanding of air pollution and inform decision-making. I am open to positions across the United States, with a preference for California. I am also willing to relocate for the job.

4JS.25

Paa Sey, Ph.D. Candidate in Mechanical Engineering Seeking Industry, Research Scientist, and Postdoctoral Roles in Air Quality and Aerosol Science. PAA SEY, *Carnegie Mellon University*

I am a Ph.D. candidate in Mechanical Engineering at Carnegie Mellon University. My past and current research centers on satellite-informed, data-driven methods to understand fine-particle pollution where ground monitoring and chemical speciation are sparse. I integrate satellite remote sensing, atmospheric composition modeling, reference-grade measurements, geospatial analysis, and statistical and machine-learning methods to turn heterogeneous observations into decision-relevant air-quality information. My dissertation forms an end-to-end framework for $PM_{2.5}$ assessment across Africa. First, I developed a ground-calibrated random-forest approach that downscales NASA GEOS-CF PM2.5 from approximately 25 km to 1 km across the continent for 2019-2024 while preserving the parent model's aggregate mass structure. The product supports finer hotspot, exposure, and trend analyses and explicitly evaluates transfer to unmonitored sites and years. Second, I am applying this high-resolution framework to population-weighted exposure and trend analysis, including uncertainty quantification. Third, I am developing a causal source-attribution framework that combines satellite trace gases, fire activity, surface observations, and meteorology to identify robust proxy-defined emission and formation processes and quantify their relationships with short-term $PM_{2.5}$ variability. My broader interests include aerosol exposure assessment, interpretable machine learning, causal inference, uncertainty quantification, and environmental decision support. I work primarily in Python, Google Earth Engine, and reproducible geospatial workflows. I anticipate defending my Ph.D. in late September 2026 and will be available beginning in October 2026. My preferred job types, in order, are industry positions, research scientist roles, and postdoctoral appointments. My geographic preference is the eastern United States, particularly Virginia, Washington, DC, Maryland, Pittsburgh, and Philadelphia; however, I am also open to relocating to New York (including New York City), California, or Texas. I am especially interested in work connecting atmospheric science, public health, and actionable air-quality management.

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4SC.1

University of California Riverside Student Chapter. ERIN BOWEY, Malsha Amugoda, Stephanie Salas, Sean Murphy, James F. Davies, *University of California, Riverside*

The UCR AAAR student chapter comprises over 50 members in inter-departmental aerosol and atmospheric science study across the UCR main and CE-CERT research campuses. UCR regularly welcomes researchers involved in aerosol and atmospheric science to speak at our seminars and give special lectures. When this happens, we often have the great opportunity to meet with the speaker personally as a chapter! This has been a wonderful experience for us as we can ask questions and learn from a broad range of scientists all across the field and all over the world. We sincerely thank all visiting researchers who have taken the time to talk with us. Additionally, a Journal Club has been reinvigorated for semiweekly sessions of discussions about a recent journal article chosen by one of our members. This helps us to be involved in open conversations on various topics in aerosol science and challenge ourselves to think beyond our own work. Apart from research-focused activities and discussions, the UCR student chapter has organized social activities including Halloween costume contests, movie nights, and picnics. In the future, UCR Student Chapter also plans to add new activities to further engage with the community. We will continue to actively engage with visiting aerosol scientists and aim to take the lead in inviting new academics to chat about their work and career paths. We would like to collaborate with other student chapters for further social engagement, skill development, and paper reading and writing activities, potentially across campuses. Please reach out to us if you are interested in working with the UCR Student Chapter to utilize and advance this broad community of AAAR members of which we are all a part!

4SC.2

Sensors Solution Hackathon (SSH); Clarkson University AAAR Student Chapter. NAGARAJAN RADHAKRISHNAN, Suresh Dhaniyala, *Clarkson University*

Rapid advances in sensing technology and artificial intelligence are converging to create new opportunities in environmental monitoring, particularly in the air quality domain. To equip students with the tools and skills necessary to take advantage of this emerging physical AI opportunity, the AAAR Student Chapter at Clarkson University organized the Sensors Solution Hackathon (SSH), a one-day, team-based event focused on practical problem-solving in sensing technology with accessible AI tools. Participant teams were presented with real air quality sensing challenges and tasked with devising measurement and mitigation solutions using readily available sensors and supplies. This presentation reports on the outcomes of the inaugural SSH, including what worked well and what needs improvement.

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4SC.3

University of California, Irvine Student Chapter. JACKSON RYAN, Dhivya Manickam, Connor Seto, B. Sage Lauper-Cook, Berenice Rojas, Colleen Miller, *University of California, Irvine*

The UC Irvine AAAR student chapter is a uniquely diverse collection of aerosol scientists that spans multiple departments including chemistry, earth systems science, and engineering. Alongside the Atmospheric Integrated Research center at UCI (AirUCI), the group hosts panels, internal seminars, wellness events, fundraisers, and outreach opportunities. The leadership team is composed of PhD students that come from different research backgrounds and varying times to degree. This diversity allows for the group to develop events that engage with both first year and final year graduate students, as well as undergraduates, post-doctoral fellows, project scientists, and faculty members. The primary goal of our student chapter is to bring our interdisciplinary community together at UC Irvine to support one another and foster an environment of collaboration. As impactful research is almost always completed through collaboration, we welcome any future collaborations with other student chapters or even with universities that may still be working to form a student chapter. We are eager to host events either in-person or virtually on topics such as aerosol research, professional development, equity and inclusion, and mental health awareness to continually broaden what it means to be a scientist.

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5AP.1

Inelastic Collisions Between Gas Molecules as Well as with Tiny Nanoparticles (TNP) and Their Impact on TNP Diffusivity in Comparison to Experimental Data. Dimitrios Tsalikis, SOTIRIS PRATSINIS, *Aristotle University of Thessaloniki, Greece*

The exact nature of collisions between gas molecules is investigated by molecular dynamics (MD) for monatomic and diatomic gases relevant to environment (e.g., air) and industry (e.g., nitrogen, noble gases). Gas molecules undergo the well-known elastic (or ballistic or specular) head-on collisions as well as inelastic (including head-on, grazing and orbiting-like) ones [1]. The latter are driven by the attractive part of the intermolecular potential and, most importantly, by the molecular shape (i.e. diatomic). Elastic from inelastic head-on collisions are distinguished by rigorous comparison of their impinging to reflection angle. This distinction is validated by classic hard-sphere MD simulations that emulate classic kinetic theory.

Monatomic gases (helium, neon, argon, krypton, xenon) predominantly undergo elastic head-on collisions. For He, more than 99% of collisions are elastic but their fraction decreases with increasing molecular size (e.g., less than 95% for Xe). In contrast, diatomic gases (hydrogen, nitrogen, oxygen) exhibit much lower fractions of elastic collisions (e.g., about 15% for air) with the rest made by orbiting and diffuse head-on collisions. The large deviation in the nature of collisions between mono and diatomic gases highlight the significance of molecular shape and rotation over that of intermolecular forces [1].

Furthermore, the nature of collisions between air molecules and nanoparticles is explored revealing that such collisions are predominantly inelastic. Their fraction increases gradually from about 87% for the smallest fullerene nanoparticle to 100% at 2 - 3 nm, depending on nanoparticle composition. Most importantly, the MD-obtained diffusivity [2] of various fullerene nanoparticles (that are used widely as standards for nanometer-sized aerosol particles [3]) is compared to most, if not all, fullerene particle diffusivities (or mobilities) measured in the last 30 years [4,5].

[1] D. Tsalikis et al., Phys. Fluids, 35, 097131 (2023).
[2] K. Karadima et al., J. Phys. Chem. A., 129, 5127−5136 (2025).
[3] H. Tanaka & K. Takeuchi, J. Aerosol Sci., 34, 51167−1173 (2003).
[4] N.G. Gotts et al., International J. Mass Spectrom. Ion Proc., 149/150, 217-229 (1995).
[5] P. Weis et al., Phys. Chem. Chem. Phys., 21, 18877-18892 (2019).

5AP.2

Using Low- and Medium-Cost Optical Particle Counters to Evaluate Turbulence-Induced Aerosol Deposition. REN GARITY, James Henry, Andrew Metcalf, John Saylor, Moein Mousavi, Prasad Rangaraju, Nigel Kaye, *Clemson University*

Sea salt aerosol (SSA) transport and deposition in spent nuclear fuel dry storage casks (SNF DSCs) poses long-term stress corrosion cracking risks to the steel canister that houses fuel rod components. Whether SSA makes it to the cylinder surface inside the concrete overpack and remains is determined by particle transport mechanisms and near-surface interactions. The transport mechanisms being investigated in this study include thermophoresis, turbophoresis, turbulent dispersion, diffusiophoresis, and Stefan flow, which are influenced by environmental conditions (flow, temperature, and humidity gradients) and particle size. From prior computational fluid dynamics (CFD) results [1][2], turbophoresis and turbulent dispersion were predicted to be the primary drivers of transport and deposition, especially in the horizontal DSC system. Our experiments aim to validate these results and establish a baseline of uncertainty.

This talk will address using calibrated low- and medium-cost optical particle counters to track movement of particles in the 1-10 micron size range through a physical lab-scale model of a horizontal SNF DSC to validate CFD modeling of bulk fluid transport and near-surface interactions of particles. Overall, this work aims to show how low- and medium-cost sensors can be integrated into monitoring risk to horizontal DSC systems, with an emphasis on defining the range of uncertainty for both experimental and computational results. We will present an overview of the physical deposition experiments in the lab-scale SNF DSC, including sensor calibration with high-cost instrumentation, sensor placement, control and measurement of critical environmental variables (ambient temperature and humidity), and generation and delivery of wet and dry [3] aerosol to the system. Additionally, we will discuss how the physical experiments were designed to best align with the CFD models and how we accounted for deterministic and stochastic uncertainty.

[1] Sarah R. Suffield, Ben J. Jensen, Philip J. Jensen, William A. Perkins, Brady D. Hanson, Steven B. Ross, Christopher L. Grant & Casey J. Spitz (2024) Computation of Particulate Deposition on Dry Storage Canisters, Nuclear Technology, 210:9, 1648-1657, DOI: 10.1080/00295450.2023.2299892.
[2] Sarah R. Suffield, William A. Perkins, Ben J. Jensen, Brady D. Hanson & Steven B. Ross (2025) Turbulent Particle Flow in Spent Nuclear Fuel Storage Systems, Nuclear Technology, 211:2, 241-257, DOI: 10.1080/00295450.2024.2324213.
[3] Ward, R. X., Hack, M., & McNeill, V. F. (2026). A low-cost solid aerosol generator of high stability. Aerosol Science and Technology, 60(1), 70–79. https://doi.org/10.1080/02786826.2025.2568021.

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5AP.3

Resolved CFD Modelling of Single-Particle Aerosol Resuspension Under Near-Wall Turbulence. NICOLAS DUTHOU, Alberto Gambaruto, *University of Bristol*

Aerosol resuspension plays a critical role in fields such as environmental exposure, healthcare, agriculture, transport, and nuclear safety, yet remains poorly predicted at the single-particle level, where detachment depends on coupled interactions between near-wall turbulence, surface morphology and adhesion. Existing models are both mechanistic and semi-empirical, and can reasonably estimate bulk resuspension trends. However, these models rely on simplifying assumptions and existing empirical data, limiting their applicability in scenarios where accurate detachment thresholds are required, particularly in scenarios where complete empirical data is not available.

This work aims to bridge this gap by introducing a Computational Fluid Dynamics (CFD) model for aerosol resuspension that explicitly resolves particle detachment mechanisms under realistic near-wall flow conditions. Implemented in Siemens Simcenter Star-CCM+, the model combines overset meshing with six-degree-of-freedom dynamic fluid-body interaction to simulate the three-dimensional particle motion. It also comprises unsteady flow structures in the particle vicinity, particle-surface contact mechanics, and adhesive interactions through a custom van der Waals force formulation. The model accommodates variable particle size, shape and surface topologies, with a focus on low-particle-Reynolds-number conditions ($Re_p \leq 1$).

Simulations of particles on structured and rough surfaces reveal distinct detachment pathways governed by the balance between aerodynamic torque, adhesive and contact-resisting moments. In particular, the transition between sliding and rocking is shown to depend sensitively on surface topology and particle geometry. Comparisons with wind tunnel experiments on spherical glass particles show consistent trends in detachment behaviour and trajectories, providing initial validation of the resolved approach.

By directly resolving the key mechanisms governing near-wall detachment, this model provides a basis for improving resuspension modelling in applications where particle-scale physics, rather than bulk parameterisations, controls exposure and contamination risk.

5AP.4

Implementation of Kinetic Partitioning of Secondary Organic Aerosols in GEOS-Chem. REGINA LUU, Meredith Schervish, Samuel O'Donnell, Jeffrey R. Pierce, Manabu Shiraiwa, *University of California, Irvine*

The phase state of secondary organic aerosols (SOA) can adopt liquid, amorphous semi-solid, or glassy solid states, affecting various multiphase processes including SOA formation and partitioning, multiphase chemistry, and cloud activation. In this study, we developed a method to simulate kinetic partitioning of SOA accounting for the impacts of SOA phase state by utilizing effective mass accommodation coefficient to modulate the particle condensation sink. We derive an approximate solution of gas-particle partitioning accounting for phase state and compare predicted mixing and equilibration timescales of partitioning. Following examination of the parameter space for bulk diffusivity, volatility, and total aerosol mass loading, we found that for most typical ambient conditions either the existing instantaneous or the computationally-efficient approximate partitioning scheme can be applied, while numerical solutions are necessary for partitioning of semi-volatile compounds into highly viscous particles. Our simulations indicate that the predicted differences in SOA budgets when accounting for phase state were most prominent over continental regions with simulated semi-solid or solid phases. In the free troposphere the existing equilibrium partitioning scheme would substantially deviate SOA mass in the equatorial and mid-latitudes.

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5AP.5

Beyond the Surface: Unlocking Aerosol Vertical Structure Through Uncrewed Aerial and Tethered Balloon Platforms.

FAN MEI, Jian Wang, Israel Silber, Qi Zhang, Nurun Nahar Lata, Gregory W. Vandergrift, Jing Li, Christopher Niedek, Bo Chen, Sarah D. Brooks, Michael Jensen, Damao Zhang, Gourihar Kulkarni, Darielle Dexheimer, Beat Schmid, Zezhen Cheng, Jason Tomlinson, Swarup China, Min Deng, *Pacific Northwest National Laboratory*

Accurate representation of aerosol vertical properties remains a critical gap in our understanding of aerosol–radiation and aerosol–cloud interactions, air quality, and aerosol transport. Surface-based measurements alone cannot capture the pronounced vertical heterogeneity that governs cloud condensation nuclei (CCN) availability at cloud base, aerosol optical profiles, and the influence of boundary-layer dynamics on aerosol populations. Drawing on multiple deployments conducted between 2022 and 2023 across contrasting environments—the U.S. Southern Great Plains (SGP) and the coastal urban Houston, Texas, region during the DOE ARM TRACER field campaign—we demonstrate how the integration of in situ microphysical, chemical, and optical measurements with remote-sensing observations provides a comprehensive, vertically resolved characterization of aerosol properties. We highlight the complementary capabilities of TBS for sustained stationary profiling and UAS for rapid, spatially flexible sampling, demonstrating how their combined use offers a more complete picture of aerosol lifecycle processes than either platform alone.

5AP.6

Improved SEM Imaging Analysis for Characterizing Microenvironmental Condition for Bioaerosol Particles.

DEEPAK SAPKOTA, Yuhui Guo, Ajay Sajan, Imtiaz Taimoor, Hui Ouyang, *The University of Texas at Dallas*

Virus-laden bioaerosol microenvironmental conditions provide important insight into airborne virus survival during aerosol transmission. The microenvironmental condition includes particle structure, size, phase state, and intraparticle chemical distribution, all of which can dynamically change during evaporation thus result in complex conditions in the suspension stage. Yet, direct characterization of aerosol particle microenvironments remains challenging because bioaerosol particles are often micro- or submicron-sized and suspended in air. Scanning electron microscopy (SEM) has been widely used to image bioaerosol particles generated under different RH conditions to visualize particle structure and surface morphology. Here, we coupled Andersen Cascade Impactor (ACI) collection with SEM imaging and energy-dispersive X-ray spectroscopy (EDX) line-scan analysis. In addition to the visualization of particle structure, we can retrieve intraparticle chemical distribution, particle phase state (liquid, semi-solid/viscous, and solid), organic-inorganic separation, crystallization, and surface characteristics. We examined particles generated from various model solutions, including virus media (VM) (MEM with 10% FBS), VM supplemented with mucin, BSA, and sucrose, and model respiratory fluids including artificial saliva and human saliva at low RH (~35%). For VM particles, we also repeat the test at 60% and 80% RH. Overall, the addition of organics generally promoted more well-mixed chemical distributions in aerosol particles at 35% RH. Interestingly, VM particles seem to have fine crystals in the middle covered by a thin layer of organic at 35% RH. VM particles shift to semi-solid at 60% and droplet at 80% RH. Clear organic-inorganic separation is observed at 60% for VM particles where organic layer fractured upon impaction and results in a bowl-shape structure with a few large salt crystals exposed in the center. Overall, this improved approach enables more detailed characterization of the microenvironmental conditions of respirable bioaerosol particles and can advance mechanistic understanding of airborne virus survival and transmission.

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5AP.7

Increasing Sea Surface Temperature Suppresses Primary Marine Aerosol Production. JUSTIN HAMLIN, Raymond Leibensperger III, Jena Herbst, Charbel Harb, Ke'La Kimble, Meinrat O. Andreae, Christopher Lee, Greg Sandstrom, M. Dale Stokes, Grant B. Deane, Kimberly Prather, *University of California San Diego*

Sea spray aerosol (SSA) influences climate through direct and indirect interactions with radiation. However, the magnitudes of these interactions remain poorly constrained, in part due to a lack of understanding of the influences of sea surface temperature (SST) on SSA production. There is no agreed-upon dependence of SSA production on SST despite numerous field, laboratory, and modelling investigations. In this presentation, we address these disagreements by contextualizing previous work. Next, we characterize the connection between SST, seawater bubble concentrations, SSA number concentrations, and SSA emission fluxes using measurements in the Scripps Ocean-Atmosphere Research Simulator (SOARS). This isolated ocean-atmosphere interaction system incorporates wind, waves, and SST controls to produce wave breaking under realistic and controlled conditions. In SOARS, increasing SST from 2 to 23 °C suppressed total subsurface bubble concentrations (between 6.17 and 830 µm) by a factor of 1.5, SSA number concentrations (between 0.008 and 20 µm) by a factor of 3, and SSA accumulation mode emission flux by a factor of 4. While prior studies report both increases and decreases with SST, these controlled wind-wave-SST experiments demonstrate that increasing SST suppresses SSA production. Resolving this SST dependence is critical, as it directly alters marine aerosol burdens, cloud condensation nuclei, and radiative forcing, and provides a needed constraint missing from current parameterizations.

5BA.1

Longitudinal Aerosol Sampling Reveals Important Drivers of Airborne Transmission of Coccidioides Posadasii and Dispersion of Fungal Communities in Arizona. Daniel Kollath, Amelia Stout, Marieke L. Ramsey, Bridget M. Barker, Pierre Herckes, MATTHEW FRASER, *Arizona State University*

Coccidioidomycosis is an environmentally acquired fungal infection with a substantial disease burden in the arid southwestern United States. The inhalation of airborne arthroconidia (spores) is the main infection route but despite this, aerosol dispersal patterns are not well defined. In this study we provide two years of pathogen aerosol detection data as well as chemical and meteorological measurements. We show seasonal patterns of pathogen presence in aerosols that are linked to crustal material and carbon particulate matter concentrations. We also examine a negative relationship with relative humidity and a positive relationship with wind speed. In addition, we examined the fungal communities of the air and soil and show distinct community assemblages. However, overlap of taxa in soil and air suggests dispersal of fungi from local soils at our study site are occurring frequently rather than long distance dispersal. This longitudinal data provides chemical and biological evidence that highlights the importance of particle entrainment on the airborne transmission of coccidioidomycosis that until recently has been an overlooked component to the disease lifecycle. A better understanding of environmental transmission patterns is crucial for predictive disease models, and we show that aerosols are an important component to this cycle.

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5BA.2

Bioaerosol Dynamics at the 2024 NASCAR Race in Fort Worth, Texas. KATHERINE ARAYA, Vivian Tat, Sarah Alnemrat, George Santarpia, Riley Watson, Kostiantyn Botnar, Sean Kinahan, Shanna A. Ratnesar-Shumate, David Kimmel, Hema Narra, Christine Tomlinson, George Golovko, Kamil Khanipov, *The University of Texas Medical Branch*

Mass gatherings pose substantial public health challenges. However, the effect of mass gatherings on bioaerosol dynamics remains poorly characterized. We analyzed 15 bioaerosol samples collected during the 2024 NASCAR race weekend at Texas Motor Speedway in Fort Worth, which has a capacity of ~75,000 attendees (Day 1, N=4; Day 2, N=3; Day 3, N=4). Samples were also collected one day after the event (Day 4, N=4). Bioaerosol samplers equipped with PTFE filters collected air at 200 liters per minute for 24 hours at the same sites on each sampling day. DNA was extracted from air filters using the ZymoBIOMICS DNA/RNA Miniprep kit. Sequencing libraries were prepared using the Oxford Nanopore Rapid PCR barcoding kit and sequenced on an Oxford Nanopore PromethION 2 Solo. High-accuracy basecalling was performed with Dorado. Species-level taxonomic profiles were generated using wf-metagenomics with Kraken2 and Bracken against the core_nt reference database. Antimicrobial resistance (AMR) genes were identified with ResFinder. A global shift in Bray-Curtis community composition was detected across sampling days by PERMANOVA ($p = 0.026$). Pairwise differential abundance identified 542 significant taxa between Day 1 and Day 3 and 365 taxa between Day 1 and Day 4 ($q < 0.05$). AMR burden was highest on the last day of the event (Day 3). These findings highlight the value of shotgun metagenomic profiling of bioaerosols to inform biosurveillance efforts in mass gathering settings.

5BA.3

Selected Research Highlights from the Biology Integration Institute: Regional OneHealth Aerobiome Discovery Network (BROADN). SONIA KREIDENWEIS, Marina Nieto-Caballero, Kevin Barry, Emily Kraus, Mark Hernandez, Jane Stewart, Carolyn Cornell, Sam Golon, Brad Borlee, *Colorado State University*

The National Science Foundation-sponsored Biology Integration Institute, BROADN, assembled a multidisciplinary team to advance study of the aerobiome, the microbiome of the Earth's atmosphere. Project teams designed experiments to study characteristics of bioaerosol sampling and analysis; conducted field work to link aerobiome dynamics to terrestrial sources and sinks; and used controlled lab studies to advance mechanistic understanding of factors governing emissions and survival of microbes while airborne.

Selected highlights of findings include the following. We confirmed published findings that lab-based aerosolization, even using relatively gentle bubble aerosolization, results in significant loss of viability for gram-positive and gram-negative bacteria tested; cell damage was sensitive to bacteria growth phase. We also showed that changes in ice nucleation activities of the tested bacteria provided a sensitive lens for detecting damage to cells and components from aerosolization and sampling.

Observations from our field study at a northern Colorado semi-arid grassland site revealed that ice-nucleating bioaerosols were strongly correlated with local rainfall intensity and amount. Further investigation revealed regional rain amount, intensity, and the land type on which it fell were the strongest predictors of biological ice nucleating particles (INP). Air mass histories of 1-2 days were the most relevant in shaping the observed INP populations, suggesting regional sources dominated over local or long-range transport. Comparison of the variation in bacterial and fungal communities between the grassland site and a higher-elevation subalpine forested site approximately 150 km distant showed greater similarity for bacterial taxa, while fungal taxa exhibited more site-specific variability.

The prevalence of bubble bursting as a mechanism of bioaerosol generation inspired the study of surfactant production as a bacterial adaptation promoting aerosolization. We conducted controlled bioaerosol generation and chamber sampling studies using a rhamnolipid-producing gram-negative bacterium and an engineered rhamnolipid-deficient strain. Initial tests indicated less bioaerosol production in the latter, as anticipated.

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5BA.4

Physicochemical Characterization of Ice Nucleating Particles in Birch Pollen. CHAMARI MAMPAGE, Miriam Freedman, *The Pennsylvania State University*

Atmospheric ice formation influences the Earth's radiation budget and hydrological cycle through its contribution to cloud formation. Aerosol particles in the atmosphere can affect ice formation by acting as ice nucleating particles (INPs). Birch pollen is known to be one of the efficient biological ice nuclei and macromolecules like polysaccharides and proteins are suggested to be responsible for its ice nucleating (IN) activity. In this study, we investigate the IN macromolecules in birch pollen wash water (BPWW). BPWW exhibited freezing properties similar to an unfiltered 0.1 wt.% pollen suspension with median freezing temperature, T_{50}, of -14 °C and -13 °C, respectively, confirming the successful transfer of ice nucleating components. Transmission electron microscopy revealed nanoscale particles in the BPWW averaging 132 nm in diameter (range 28–756 nm). To investigate the chemical composition of these particles we conducted enzyme digestion for pectin, starch, and proteins. Enzyme digestion with pectinase decreased the T_{50} of both commercial pectin and BPWW by ~ 2 °C, indicating the likely contribution of pectin in the IN activity of BPWW. Commercially available starch was observed to nucleate ice and the amylase digestion decrease the T_{50} by 13°C. A significant decrease in the IN activity was not observed for BPWW, suggesting that starch is not a contributing macromolecule to the IN activity of BPWW. Proteins precipitated from BPWW showed efficient IN activity similar to the original extract. As the remaining protein-depleted fraction still successfully nucleated ice, it is evident that the IN activity of BPWW stems from a combination of multiple macromolecules. Enzyme digestion experiments are underway to confirm the contribution from these proteins in the IN activity of BPWW. Identifying the chemical composition of these IN macromolecules will provide critical insight into the role of pollen in atmospheric ice formation.

5BA.5

What Bacteria Say When They Fly: Gene Expression Profiling of Airborne Mycobacterium parafortuitum. EMILY KRAUS, Samuel Bryan, Mark Hernandez, *University of Colorado Boulder*

Airborne microorganisms can pose substantial risks to human, agricultural, and environmental health, yet the physiological responses that enable microbial persistence in aerosols remain poorly understood. Transcriptomic studies of bioaerosols can provide indications of microbial responses to stressors associated with airborne suspension; however, they are technically challenging due to rapid intracellular mRNA turnover and analytical artifacts associated with low biomass recovery. To address these challenges, a controlled experimental framework was developed for time-resolved transcriptomic analysis of airborne *Mycobacterium parafortuitum*, a surrogate for the environmental behavior of *Mycobacterium tuberculosis*. Log phase cultures (~10^9CFU/mL) were aerosolized into respirable particle sizes contained within a 10 m^3 climate-controlled chamber. Bioaerosol was collected in repeated 5-minute intervals (over a one hour suspension period) via condensation capture into an RNA preservative. Samples were analyzed using culture-based viability assays, qPCR, and mRNA purification and sequencing. Comparative transcriptomic analysis revealed rapid and coordinated physiological adaptation to an airborne state following aerosolization. Within minutes of airborne suspension, cells upregulated genes associated with redox homeostasis, detoxification, transport regulation, and membrane stress responses, accompanied by downregulation of growth-associated biosynthetic pathways observed in liquid culture controls prior to aerosolization. As airborne residence time increased, transcriptional profiles progressively shifted toward lipid metabolism and membrane remodeling, consistent with a persistence survival state. Notably, several host/interface-associated genes were induced despite the absence of host interaction. These findings suggest that aerosolization induces an immediate transition from anabolic growth toward a lipid-driven, redox-buffered survival physiology adapted for airborne persistence in *M. parafortuitum*. Beyond the biological findings, this work establishes an experimental framework for high-resolution transcriptomic studies of bioaerosols under controlled environmental conditions. The approach supports a mechanistic understanding of how air quality conditions and engineering interventions (e.g., RH, UV exposure, ozone, and other disinfectants) affect the persistence of airborne microbes from a fundamental biochemical perspective.

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5BA.6

Interannual Variability of Pollen Rupture and Convective Transport over the Bankhead National Forest. TAMANNA SUBBA, Allison Steiner, Maria A. Zawadowicz, Ashish Singh, Nurun Nahar Lata, Zezhen Cheng, Gregory W. Vandergrift, Ashfiqur Rahman, Darielle Dexheimer, Casey Longbottom, Gabrielle Whitson, Carlos Ruiz, Shawn Serbin, Scott Giangrande, Swarup China, Chongai Kuang, *Brookhaven National Laboratory*

Biological aerosols remain a poorly constrained component of aerosol-cloud coupling over forested regions. Primary pollen grains can rupture into sub-pollen particles, altering aerosol number and mass concentrations and potentially influencing cloud microphysical processes; however, uncertainties remain in rupture frequency, vertical transport, and regional impacts. This study investigates interannual variability in pollen and sub-pollen particle behavior over the southeastern United States from October 2024 to May 2026, with a focus on peak pollen emission periods. We combine ARM AMF3 observations at Bankhead National Forest (BNF) with high-resolution WRF-Chem simulations. Observations at the BNF main site primarily include lidar depolarization ratio, aerosol size distributions, bulk aerosol mass concentrations, and meteorological variables, complemented by surface and vertical aerosol measurements from tethered balloon system deployments (2025 and 2026). Initial analyses show interannual variability in possible pollen-particle events (PPEs) during March-April 2025 and 2026, the peak tree-pollen season in northern Alabama. Overall, 4-12 PPE days per month were identified, representing up to ~36% of days. PPEs are associated with enhanced particle number concentrations above 130 nm and increased coarse-mode aerosol abundance. Because pollen transformation processes are particularly influenced by convective events, we focus 1-km WRF-Chem simulations on the 15-16 March 2025 event, comparing no-pollen, primary-pollen, and primary-plus-sub-pollen conditions. Primary pollen remains mostly below ~3 km, whereas sub-pollen particles are lofted to ~12 km during convection. Modeled total aerosol mass concentrations increase from ~5 μg m^{-3} without pollen to ~9-10 μg m^{-3} with primary pollen, with broader variability when sub-pollen is included. These results highlight ecosystem phenology and convective meteorology as key controls on bioaerosol impacts on aerosol budgets and cloud processes.

5BA.7

From Sewage to Sea Spray: Multi-Omic Characterization of the Coastal Aerobiome. MAILE HEYER, Alice Levesque, Ariel Rabines, Greg Sandstrom, Lisa Zeigler, Kimberly Prather, *University of California San Diego*

The aerobiome, defined as the collection of microorganisms in a given airspace, plays important roles in ecosystem dynamics, atmospheric processes, and human health, yet remains among the least studied Earth microbiome due to the challenges of sampling a dilute and dynamic environment. Most aerobiome studies rely on amplicon sequencing (16S, 18S, etc.), limiting taxonomic resolution and largely excluding viruses and microbial functional potential. Additionally, RNA and RNA viruses are rarely investigated because low-biomass air samples are difficult to process and current extraction methods are often not optimized for environmental inhibitors or RNA preservation.

This study examines the coastal aerobiome, where terrestrial, anthropogenic, and marine bioaerosol sources intermix in response to environmental drivers such as wind direction. Using integrated meta-omic approaches, including shotgun metagenomics and metatranscriptomics, we aim to characterize airborne microbial and viral communities at strain-level resolution. We also evaluated and optimized nucleic acid extraction workflows for low-biomass aerosol samples to improve recovery of environmental DNA and RNA.

Four month-long field campaigns were conducted in Southern San Diego (SSD), where recurrent pollution from the Tijuana River introduces sewage, urban runoff, and industrial wastewater into the Tijuana Estuary (USA) and coastal ocean. Turbulent water flow from elevated river discharge and coastal wave breaking can aerosolize contaminants and release gasses, creating a potential airborne exposure pathway for wastewater. We collected daily air samples alongside water and sediment to assess temporal variability and potential source contributions. Preliminary data show relationships between pollution events, meteorological conditions, and airborne DNA and RNA concentrations. Transmission electron microscopy (TEM) revealed intact viral particles in air samples. Ongoing meta-omic sequencing and targeted human norovirus RT-ddPCR analyses are being used to investigate pathogen aerosolization and transport from water to air. Future metatranscriptomic sequencing and propidium monoazide assays will help understand activity and viability.

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5CC.1

Laboratory Characterization of Aerosol Activation and Mixing State Evolution During Cloud Processing. RYAN FARLEY, Kyle Gorkowski, Katherine Benedict, James E. Lee, Manvendra Dubey, Allison Aiken, *Los Alamos National Laboratory*

Aerosol-cloud-precipitation interactions remain a major source of uncertainty in the global earth system. To investigate these processes, a 906 L cloud processing chamber was developed at Los Alamos National Laboratory, enabling precise control of aerosol concentration, composition and size as well as ambient supersaturation. The chamber was validated under warm-cloud conditions using seed aerosol spanning atmospherically relevant hygroscopicities, ranging from ammonium chloride ($\kappa = 0.93$) to bis(2-ethylhexyl) sebacate ($\kappa \approx 0$). The cloud droplet size distributions were monitored directly with an aerodynamic particle sizer modified for integration with the cloud chamber, with geometric mean diameters between 3.5 and 5 µm. Simultaneously, the droplet residuals were characterized using a pumped counterflow virtual impactor (PCVI) followed by a soot particle aerosol mass spectrometer (SP-AMS) and scanning mobility particle sizer (SMPS) to provide aerosol chemical composition and size distributions. Subsequent experiments introduced size-selected, externally mixed aerosol populations with contrasting hygroscopicities to explore competitive droplet activation under controlled conditions. The evolution of the mixing state of droplet residuals and the aerosol population following cloud evaporation was quantified using SP-AMS event-trigger single particle measurements. These experiments provide direct measurements of the change of aerosol mixing state during cloud processing under conditions relevant to warm, marine stratocumulus clouds, such as observed during the Eastern Pacific Cloud Aerosol Precipitation Experiment (EPCAPE) campaign and provides new constraints on how cloud processing affects aerosol hygroscopicity and CCN activity, with implications for representation of aerosol-cloud interactions in climate models.

5CC.2

Hygroscopicity of Organic Matter: The Role of Functional Groups. NAGENDRA RAPARTHI, Ann M. Dillner, Anthony S. Wexler, *University of California, Davis*

The hygroscopicity of ambient aerosol particles plays a critical role in regulating cloud formation, atmospheric chemistry, and radiative forcing. Among aerosol constituents, organic matter (OM) remains one of the most complex and least constrained components due to its compositional diversity, comprising thousands of individual compounds with varying physicochemical properties. This complexity introduces substantial uncertainty in predicting OM hygroscopic behavior and its representation in atmospheric models. In this study, we investigate the hygroscopicity of ambient organic aerosol with a focus on its dependence on functionality. Hygroscopic growth measurements were conducted on atmospherically relevant samples, and the contribution of OM to overall particle water uptake was isolated and analyzed. We examine how variability in functional groups influences hygroscopic response under subsaturated conditions. Our results suggest that OM hygroscopicity is not a bulk-invariant property but is strongly modulated by its functional group composition and degree of oxidation. By linking measured hygroscopic growth to molecular-level characteristics, this work provides new constraints on the parameterization of organic aerosols in climate and air quality models. These findings highlight the importance of organic chemical characterization in improving predictions of atmospheric water uptake and aerosol-cloud interactions.

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5CC.3

Impact of Long-Range and Local Transport on the Hygroscopic Growth of Atmospheric Aerosol Particles at Skidaway Island, Georgia. MARA SHIELDS, Ariana Deegan, Abigail Sanders, Ellie Smerznak, Kathryn Zimmerman, Amanda Frossard, *University of Georgia*

The local and long-range transport of aerosols from specific source regions, as well as atmospheric processing during transport, contribute to the complex physicochemical properties of atmospheric aerosol and thus particle hygroscopic properties. Hygroscopic growth factors (HGF) of submicron particles were measured using a Humidified-Tandem Differential Mobility Analyzer at Skidaway Island, GA in summer (June 2024) and winter (January 2025). Air mass back-trajectories were calculated using NOAA's Hybrid Single-Particle Lagrangian Integrated Trajectory model. Air mass back trajectories were clustered, and source regions were identified as marine, mixed, or continental. Additionally, measured wind directions were split into eight sectors, with western (NW, W, SW) and eastern (NE, E, SE) sectors generally continental and marine influenced, respectively. The particles were identified as non-hygroscopic (HGF<1.15), less-hygroscopic (1.15<HGF<1.36), or more-hygroscopic (1.36<HGF). The highest fractions of more-hygroscopic particles were found in either the marine air mass (0.96) or the eastern wind sectors (0.49-0.76) in summer, which suggests that marine sources, whether local or long-range, produce more hygroscopic particles, which may act as cloud condensation nuclei. The non-hygroscopic fraction was found to be higher in continental air masses (0.35-0.54) and western wind sectors (0.41-0.57) in winter, which could be due to anthropogenic emissions from the upwind city of Savannah. A hygroscopic external mixing state could sometimes be observed in the data when two or more different HGF groups simultaneously occurred. The presence of a hygroscopic external mixing state was partly influenced by wind direction, with higher frequencies seen in western sectors (38.5-60.0%) compared to eastern sectors (5.3-29.4%) in summer. The variability in the hygroscopic properties of these particles demonstrate that seasonality and long-range transport as well as local emissions can influence the mixing state and cloud condensation nuclei potential of atmospheric particles.

5CC.4

From κ to χ: Evaluating and Applying Hygroscopicity-Based Aerosol Mixing State Estimates Across Diverse Environments. Yicen Liu, Shengqian Zhou, Jian Wang, NICOLE RIEMER, *University of Illinois Urbana-Champaign*

Aerosol mixing state governs critical atmospheric processes, including cloud activation, radiative interactions, and multiphase chemistry. Quantifying the aerosol mixing state index (χ) requires detailed single-particle mass fractions, which can be obtained through particle-resolved models or single-particle measurements, both are expensive and impractical for long-term, multi-site deployments. Yuan and Zhao (2023) proposed a promising alternative to infer χ from in-situ hygroscopicity (κ) distributions measured by a hygroscopicity tandem differential mobility analyzer (HTDMA). However, the method assumes a binary system of more hygroscopic and less hygroscopic species, which may oversimplify chemical variability and introduce systematic biases.

In this work, we systematically evaluate this retrieval using the particle-resolved model PartMC-MOSAIC as a benchmark. We generated a large ensemble of urban plume simulations spanning a wide range of emissions, aging conditions, and meteorology. For each population and particle diameter (50–250 nm), we compared the "true" χ derived from per-particle composition (χ_PMC) with the retrieved χ using the Yuan and Zhao method (χ_YZ). The retrieval performs well across most conditions, but systematically overestimates χ when externally mixed intermediate-hygroscopicity components violate the binary assumption. Additional limitations are identified under marine-influenced conditions. We then apply the validated retrieval to long-term HTDMA measurements to construct a multi-site, size-resolved climatology of aerosol mixing state. Results indicate that ambient aerosol populations are generally closer to the internally mixed limit, with clear variability across seasons, locations, and particle sizes. These results provide observational constraints on aerosol mixing state across diverse environments and have implications for improving representations of aerosol–cloud interactions in atmospheric models.

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5CC.5

Joint Contribution of Spatiotemporal Influences and Chemical Composition on the Hygroscopicity of Aerosol Particles in the Southern Great Plains. KYLE P. MCCARY, Rylen Pereira, Alan R. Gonzalez, Xiangxinyue Meng, Ajith Thenoor Chandran, Heewon Yim, Maria A. Zawadowicz, John Shilling, Qi Ying, Yue Zhang, *Texas A&M University*

The source and composition of atmospheric aerosols have significant impacts on cloud condensation nuclei (CCN) properties of aerosols, altering precipitation processes and radiative forcings. Although many studies of CCN occur on the ground, aircraft data analyses, especially spanning multiple months, are rare and thus CCN properties aloft are understudied. To bridge the above knowledge gap, this study examined data from the Holistic Interactions of Shallow Clouds, Aerosols, and Land-Ecosystems (HI-SCALE) aircraft campaign to systematically quantify activated fraction and cloud condensation nuclei closure under different environmental conditions from a suite of aircraft and ground instruments. Through the data analysis, we also have resolved common biases present in the mathematical order of operations when performing the closure analysis of organic hygroscopicity. Subsequent positive matrix factorization (PMF) was employed to analyze the mass spectra of organic and inorganic aerosol mass alongside aerosol size distribution data, creating a unique four-factor solution representing complex multi-regional sources. Combining these results, we have shown that an external mixture was best suited to represent aerosol species in this region, and the hygroscopicity of organic aerosols showed strong dependence on altitude and origin of the air mass, with increasing hygroscopicity of organics at higher altitude. Seasonality from Spring to Fall displayed noticeable shifts in bulk organic hygroscopicity, demonstrating the importance of accounting for seasonality in CCN activity modeling. The organic hygroscopicity parameterization was then developed based on a multivariable linear regression analysis encompassing PMF factors, demonstrating significantly improved predictability of organic hygroscopicity at each air mass region, further highlighting the importance of considering both air mass and chemical composition in modeling aerosol-cloud interactions and organic hygroscopicity values.

5CC.6

When Is a Hoppel Minimum Really a Hoppel Minimum? LYNN M. RUSSELL, Abigail Williams, Jeramy Dedrick, Georges Saliba, Timothy Bates, Patricia Quinn, *Scripps/University of California San Diego*

The “Hoppel minimum” or “Hoppel gap” refers to the local minimum in particle number concentration between the Aitken and accumulation modes that William Hoppel identified in the 1980s as forming from repeated cloud processing of aerosol particles in regions with limited emission sources. This definition implies that the diameter of this minimum in concentration corresponds approximately to the critical diameter of the highest cloud supersaturation during recent cloud cycles, with the most recent cycles having a stronger effect than those occurring substantially upwind. Hoppel minima have been observed most frequently in regions where aerosol sources are limited and boundary layer clouds are frequent. Here we compare the relationships between aerosol size distributions and cloud supersaturations from the Atlantic and Pacific Oceans, using data sets from the North Atlantic Aerosol and Marine Ecosystem Study (NAAMES), the Cold-Air Outbreaks in the Marine Boundary Layer Experiment (COMBLE), the Layered Aerosol Smoke Interactions with Cloud (LASIC) campaign, and the Eastern Pacific Cloud Aerosol Precipitation Experiment (EPCAPE). The results show that the Hoppel minimum diameters are sometimes correlated to cloud properties, showing evidence that the gap was formed by in-cloud uptake or scavenging. In such cases, the Hoppel minimum and the particle composition can be used to calculate the effective cloud supersaturation and provide evidence of a feedback effect of aerosols on clouds. In other regions, changes in the Hoppel minimum are indicative of particle composition differences or cloud scavenging, reflecting particle losses in the Aitken mode that may mask the signature of the critical diameter. Together these observations provide region-specific evidence of aerosol-cloud interactions, showing that aerosol size distributions are affected by and have effects on the supersaturations of the clouds that activate and process them.

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5CC.7

Surfactant Properties and Particle Hygroscopic Growth Vary with Air Mass Source Region and Season at Skidaway Island, Georgia. AMANDA FROSSARD, Mara Shields, Ariana Deegan, Anastasia Watson, Abigail Sanders, Ellie Smerznak, Kathryn Zimmerman, Tret Burdette, *University of Georgia*

The chemical and physical properties of atmospheric aerosol particles, and their ability to act as cloud condensation nuclei (CCN) are dependent on many factors, including their sources and processing in the atmosphere. Surfactants, surface-active organic molecules, reduce the surface tension of aerosol particles, and their composition and strength vary as a function of aerosol source. In this study, we show that air mass source region from which particles originate, as well as season, influences particle hygroscopic growth, surfactant properties within the particles, and the potential for new particle formation. The chemical and physical properties of aerosol particles were measured during summer (June 2024) and winter (January 2025) at a coastal site on Skidaway Island, GA. Here, we show variability in submicron particle hygroscopic growth as function of air mass source region, with the more hygroscopic particles from marine-influenced air masses. Particles had higher hygroscopic growth factors in the summer (average of 1.32 ± 0.16), compared to the winter (average of 1.19 ± 0.12). In the winter, two new particle formation events contributed to the formation of oxygenated organosulfates, which can be surfactant-like. One of the events also coincided with two externally mixed hygroscopic growth factor modes, with one more hygroscopic and one less hygroscopic mode (average growth factors of 1.46 ± 0.02 and 1.22 ± 0.04, respectively). Surfactants contributed to a larger fraction of the particle mass in the summer than the winter, and surfactants in particles from marine-influenced air masses had more lipid-like structures than those from continental source regions. Atmospheric processing and long-range transport contributed to lower particle hygroscopic growth factors, in both seasons, as well as surfactants with smaller carbon chain lengths. This demonstrates the variability in particle hygroscopic growth and surfactant properties, with differences in air mass source regions, both of which influence particle CCN potential.

5ES.1

Particle Size, Concentration & Mass Calibrator. FRED BRECHTEL, Andy Corless, Xerxes Lopez-Yglesias, Nicholas Veizades, Gregory Veizades, *Brechtel Mfg. Inc*

A method to validate the response of low-cost aerosol sensors and field-deployed research-grade aerosol instruments is needed. We describe the continued development of a **P**ortable, **L**ow-cost, and **EAS**y-to-use **CAL**ibration (PLEASCAL) system. The device is completely self-contained, with aerosol generator, dryer, charge neutralizer, particle size selector, particle counter and battery. PLEASCAL requires no external pumps or power and is the size of a piece of carry-on luggage. Multiple configurations are possible. For example, one version may only include the aerosol generator, dryer, charge neutralizer, pumps and battery so polystyrene latex spheres of known sizes can be easily produced to challenge instruments in the field with a portable package.

PLEASCAL is built around an aerosol generator, differential mobility analyzer, and particle counter that have been 3D printed and otherwise redesigned to reduce cost. A micro-computer and software control PLEASCAL, communicate with the device under test, and generate a report with test results. Impactors are used to reduce the influence of multiply charged particles on the uncertainty in delivered mass concentrations. The complete system is packaged inside a small weatherproof pelican case.

PLEASCAL operates in a monodisperse aerosol testing mode, where the device under test is challenged with known size, concentration, and composition aerosol generated by PLEASCAL. Particle diameters between 10 and 500 nm may be generated, and the concentration output can be controlled through a built-in dilution system. PLEASCAL is designed to validate electrometers and CPCs (total number concentration), scanning electrical mobility sizers and optical particle counters (particle sizing), mass spectrometers and other particle mass measurements (total mass for particles smaller than 500 nm), and light absorption photometers (light absorption coefficient and absorbing aerosol mass concentration).

To demonstrate PLEASCAL, example validation tests of a Model 1720 MCPC and a Model 9404 mini-SEMS will be performed.

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5ES.2

Sampling Indoor Particulate Matter and Volatile Organic Compound Pollution Using a Mail-Away Approach with Access Sensor Technologies' Home Health Box. JESSICA TRYNER, Xiaoying Li, Olivia Cecil, Mollie Phillips, John Volckens, Ellison Carter, *Access Sensor Technologies*

People spend most of their time indoors and therefore receive most of their exposure to air pollution indoors; however, data on indoor air pollution are sparse, in part due to the logistical challenges of collecting measurements from a multitude of discrete indoor environments. Access Sensor Technologies designed the Home Health Box (HHB) to make it easier to sample multiple particulate and gaseous air pollutants indoors using one quiet and easy-to-deploy instrument. In a recent study, HHBs were used to collect approximately 250 unique week-long measurements of indoor PM_{10}, $PM_{2.5}$, VOC, CO_2, and NO_2 pollution from 100 homes across Colorado and New Mexico. Time-integrated $PM_{2.5}$, PM_{10}, and VOC samples—as well as 30-s time-resolved sensor data on PM, CO_2, and NO_2 levels—were collected during each week-long measurement. PM and VOCs were sampled onto polytetrafluoroethylene filters and Markes SafeLok Carbopack X thermal desorption tubes, respectively. Each HHB was loaded with sample media and pre-programmed in a laboratory before being shipped to a home. A home occupant only had to unpack the HHB, plug it in, and power it on to start the sample. The HHB shut down automatically when the sample was complete and was then shipped back by the occupant (using a pre-paid label provided by the study team). Overall, 92% (228/249) of attempted week-long measurements were completed successfully. PM and VOC samples facilitated compositionally-resolved measurements of those pollutants, while time-resolved sensor data were used to estimate air exchange rates and peak NO_2 concentrations. Measurements of one-week-average indoor $PM_{2.5}$, PM_{10}, benzene and 1,4-dichlorobenzene concentrations were above the limit of detection for 98%, 100%, 31%, and 86% of samples, respectively, that were completed and analyzed successfully. This presentation will describe the HHB design, sample programming, and study design features that facilitated this "mail-away" sampling approach.

5ES.3

Understanding Xact 625I MDL's, Lod's, and Total Reported Concentration Uncertainties for Comparison Studies. JAMIE BERG-CABASAAN, *Sailbri Cooper Inc*

SCI's Xact® 625i is designed for high time resolution multi-metals monitoring of ambient air, with detection limits that rival those of laboratory analysis. When analyzing Xact® 625i data for comparison to other reference methods, a commonly asked question is how best to express those results that are near or below the limit of detection. Proper treatment of such data has four important performance criteria to consider: Minimum Decision Limit, Minimum Detection Limit, Limit of Detection (LoD), and Total Reported Concentration Uncertainty. The purpose of this presentation is to better define those terms with reference to Xact 625i's performance and published MDL's and offer reasonable methodologies for interpreting low concentration data.

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5IM.1

Real-Time Analysis of Trace Metals in Air by Microwave Induced Plasma Time-of-Flight Mass Spectrometry (mipTOF).
MAYA ABOU-GHANEM, Martin Tanner, Alexander Gundlach-Graham, Jay Slowik, Ed Fortner, John Jayne, *TOFWERK*

Determination of the elemental composition of airborne nanoparticles and microparticles is essential for understanding their sources and predicting potential health effects. The most common approach for metal analysis in air is to collect samples onto filters and subsequently analyze digests by ICP-MS; however, this strategy offers poor time resolution (e.g., days) and provides only bulk elemental composition information. To understand the spatiotemporal characteristics of metal-containing aerosol emissions—which is key to assessing exposure—real-time analytical strategies are essential. Here, we report the development of a microwave-induced plasma time-of-flight mass spectrometer (mipTOF) for the direct analysis of metal-containing airborne particles.

The mipTOF is a field-deployable trace-element mass spectrometer that uses a nitrogen-sustained, high-power plasma (MICAP, Radom Instruments) to quantitatively vaporize and atomize aerosols ranging in size from ultrafine particles to PM10. Singly charged atomic ions are generated in the plasma with high efficiency (up to 99%) and subsequently extracted into the mass spectrometer, where they are separated by mass-to-charge ratio and detected. Ambient air is sampled into the plasma via a concentric pneumatic nebulizer configured as a Venturi pump at flow rates of 100–200 cm^3 min^{-1}. Using the mipTOF, concentration limits of detection range from 10 ng m^{-3} (potassium) to 0.05 ng m^{-3} (lead), with a time resolution of 10 s. The high sensitivity and fast measurement capability of the mipTOF enable new research into real-time spatiotemporal analysis of metals in air.

Finally, we demonstrate the deployment of the mipTOF for mobile measurements in Switzerland and Massachusetts, USA. In these measurements, we identified several unique sources of airborne metals, including emissions from automotive brake wear, trains, metal-plating industries, cement manufacturers, and light aircraft. These results highlight the ability of the mipTOF to identify spatially and temporally resolved sources of metal-containing aerosols in real-time under real-world conditions.

5IM.2

Inline Gas Chromatography for Rapid Separation of Gases in Practice and Predictions.
TALHA JUBAIR, Chien Nguyen, Adam Lahouar, James Hurley, Anum Khan, Namrata Shanmukh Panji, Jesse Kroll, John Michalek, Hoda Eldardiry, Gabriel Isaacman-VanWertz, *Virginia Tech*

Hazardous air pollutants (HAPs) such as benzene, toluene, and acrolein pose significant health risks even at low concentrations. However, conventional measurement methods are often expensive, stationary, and lack the temporal and spatial resolution needed for effective air toxics surveillance in communities. Therefore, we develop an inline gas chromatography (GC) sampling inlet for near real-time resolution of individual analytes. The system samples directly through a short GC column (2 m), switching between a sample of interest and clean air as a carrier gas. This approach achieves coarse separation on a single GC column under isothermal conditions with reproducible retention times and peak shapes. Though applicable to a wide range of detectors with varying selectivity and sensitivity, we examine the use of a new low-dead-volume photoionization detector (PID) as a sensor. We demonstrate detection limits down to tens of ppb for several HAPs with baseline chromatographic separation of compounds less than half a carbon number apart in retention index and a time resolution less than one minute. Using a PID facilitates portability and reduces cost, but does not provide high chemical resolution. We extend this work to include different columns, spanning polar, mid-polarity, and non-polar phases to examine the utility of orthogonal column phases for compound resolution. We inform this implementation with machine learning trained on the National Institute of Standards and Technology (NIST) retention information database to evaluate the potential for resolution provided by orthogonal column phases. We predict that retention indices from just two orthogonal phases can exclude more than 99.5% of the largest libraries of analytes, even when indices on both phases are not experimentally known. Overall, we will evaluate the system using known gas mixtures, quantify its accuracy and sensitivity, place it in the context of predictions, and discuss design strategies to address engineering tradeoffs and validation pathways.

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5IM.3

Chemical Ionization Mass Spectrometry Utilizing Benzene Cations for Measurements of Volatile Organic Compounds and Nitric Oxide. UMA PUTTU, Jamie R. Kamp, Xiaoyu Chen, Jhao-Hong Chen, Bingru Wang, Jing Li, Miquel A. Gonzalez-Meler, Jian Wang, Lu Xu, *Washington University in St. Louis*

We evaluate the capability of chemical ionization mass spectrometry (CIMS) using benzene cations as reagent ions (benzene CIMS) for detecting atmospheric trace gases. We characterize the ionization pathways and product ion distributions for 27 analytes spanning diverse chemical classes. To interpret the complex ion chemistry involving two reagent ions ($C_6H_6^+$ and $(C_6H_6)_2^+$) and multiple ionization pathways (charge transfer, proton transfer, adduct formation, and hydride abstraction), we introduce a thermodynamics-based framework that classifies analytes into three categories based on their ionization energy (IE), relative to those of benzene monomer (9.24 eV) and dimer (8.69 eV). Each class exhibits distinct ionization mechanisms and product ions. Analytes with IE smaller than 8.69 eV (low IE) undergo charge transfer with both reagent ions; analytes with IE between 8.69 and 9.24 eV (mid IE) undergo charge transfer with $C_6H_6^+$ and potential adduct formation with $(C_6H_6)_2^+$; analytes with IE larger than 9.24 eV (high IE) could undergo adduct formation, proton transfer, or hydride abstraction. Analytes within each class also show similar sensitivity, enabling sensitivity estimation for compounds lacking calibration standards. In addition to volatile organic compounds (VOCs), benzene CIMS detects nitric oxide (NO) with a detection limit of 5 pptv for 1 min integration time, exceeding the performance of most commercial NO_x analyzers. Field deployments in Chicago and St. Louis demonstrate good agreement with reference NO measurements. Isoprene measurements show good agreement with a co-located gas chromatography–photoionization detector (GC-PID) in St. Louis, but exhibit substantial positive bias in Chicago, likely due to interferences from anthropogenic VOCs in the polluted urban environment. These results highlight the potential of benzene CIMS for concurrent measurements of NO, VOCs, and their oxidation products using a single instrument, while also underscoring challenges in complex atmospheric conditions.

5IM.4

A New Approach to Reduced Nitrogen Identification and Quantification from Aerosol Mass Spectrometry Measurements. GUY SYMONDS, Pedro Campuzano-Jost, Dongwook Kim, Douglas A. Day, Qi Zhang, Xinlei Ge, Benjamin A. Nault, Hongyu Guo, Demetrios Pagonis, Jose-Luis Jimenez, *University of Colorado Boulder*

Reduced organic aerosol nitrogen (ROAN) species, such as amines, amides, and amino acids are often present in ambient particles but are seldom identified by standard analysis techniques. Smaller amines are known to nucleate particles. While some techniques do exist for detection of ROAN species in aerosol mass spectrometer (AMS) data, they are limited. A new diagnostic was developed for detecting the presence of ROAN species with the Aerodyne AMS and evaluated with ambient data covering a wide range of locations and conditions.

The new diagnostic relies on deviations in the ratios between reduced nitrogen ions (NH_x^+) in AMS spectra. These ion ratios (NH^+/NH_2^+ and NH^+/NH_3^+) are generally very consistent for ammonium salts, both in calibrations and ambient data (0.068 ± 0.010 and 1.23 ± 0.04, respectively). Small differences between instruments can be corrected for based on the routine NH_4NO_3 AMS sensitivity calibration. Most ambient datasets show results very similar to ammonium, so these ratios are not routinely examined. Analysis of dozens of ROAN laboratory standards shows that these ratios deviate significantly from NH_4^+ values for at least one of these ratios. Thus, a 2D framework of these ions in ambient data can help identify the presence of ROAN species. Ongoing work is investigating the information content of this diagnostic and its potential for quantification and apportionment, including comparisons with other techniques. Fresh biomass burning smoke often contains significant ROAN. The lifetime of ROAN from biomass burning is relatively short, on the order of several hours. Patterns in the 2D plot allow excluding many common amines as contributing majorly to ambient ROAN. On the other hand, the 2D diagnostic suggests that dimethylamine and trimethylamine could be major components of ROAN with further analysis ongoing.

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5IM.5

PySP2: An Open Source Framework for Single Particle Soot Photometer Data Processing. ROBERT JACKSON, Jessica Gasparik, John Backman, Arthur J. Sedlacek, Jesse Steiner, Kristie Stower, Barabara Bertozzi, Andrew Metcalf, Eddie Schuman, Adam Theisen, Zachary Sherman, *Argonne National Laboratory*

The Single Particle Soot Photometer (SP2) collects particle-resolved statistics on the mass loading of refractory black carbon (rBC) aerosols and the size distribution of rBC-containing particle ensembles. Due to the very high volume of data created with such particle-resolved measurements, a significant amount of data processing is required to generate the end product statistics – individual rBC-containing particle masses and sizes for particle mass and size distributions, respectively. Typically these data have been processed using manufacturer-provided code developed in IGOR Pro, a proprietary data analysis package without the capability to scale to high performance computing clusters. Therefore, post-processing of field campaign data from the SP2 can take multiple months using the IGOR Pro-based codes, which is prohibitive for continuous operation of the SP2. In addition, the proprietary nature of IGOR Pro can be cost prohibitive for institutions wishing to process SP2 data.

These issues motivated the development of an open source SP2 data processing framework called PySP2. PySP2 is a modernization of the manufacturer-provided IGOR Pro-based code into Python. PySP2 is based on the Scientific Python ecosystem, an industry standard open source suite of packages. This modernization has enabled parallel processing of rBC-containing particle statistics. As a result, this has enabled the operationalization of the SP2 for five U.S. Department of Energy Atmospheric Radiation Measurement Mobile Facility deployments. In addition, PySP2 has spearheaded an international effort to standardize SP2 and SP2 XR processing. The current roadmap includes operationalizing leading-edge only (LEO) fits that construct the optical diameter of the rBC containing particle prior to losing any coating due to evaporation in the laser beam as the particle heats up. Also, we are developing processing techniques that acquire the mixing state (coating-to-core mass ratio) of an rBC-containing particle.

5IM.6

Advancing Field-Deployable Single Particle Mass Spectrometry for Airborne Atomic Detection in Forensic Applications. ALLA ZELENYUK, *Pacific Northwest National Laboratory*

Field-deployable single-particle mass spectrometry (SPMS) could enable rapid isotopic fingerprinting of airborne particles for applications ranging from atmospheric source apportionment to nuclear forensics. A key barrier is that single-particle laser ablation mass spectra often exhibit broadened peaks and abundant oxide/cluster ions, which reduce effective resolving power and bias isotope ratios. Here we report advances with PNNL's miniSPLAT, a portable single-particle laser desorption/ionization mass spectrometer with a dual-polarity Z-TOF analyzer, aimed at robust isotope quantification in individual particles.

We systematically evaluated delayed-pulse extraction as a means to improve time focusing of ions formed within the expanding ablation plume. Implementing and optimizing delayed extraction produced a substantial improvement in mass spectral resolution and peak definition, directly improving isotopic peak separation and isotope-ratio precision. Using single particles generated from an aqueous solution of cerium(III) nitrate hexahydrate as a test system, miniSPLAT resolved and quantified not only the major cerium isotopes (^{140}Ce and ^{142}Ce) but also the low-abundance ^{136}Ce and ^{138}Ce within individual particles - capabilities that were previously limited by peak shape in conventional single-particle TOF operation.

We further examined how ion signal and isotope ratios depend on (i) particle size/mass (using size-selected particles), (ii) internal mixing with other constituents (matrix effects), and (iii) laser power density. Increasing power density shifted ion formation toward atomic ions and away from molecular fragments, oxides, and clusters, simplifying spectra and reducing interferences that complicate isotope quantification.

Beyond isotopic analysis, miniSPLAT provides information on particle size, shape, density, and simultaneous positive- and negative-ion spectra, enabling identification of coexisting particle components (often complementary across polarities) and strengthening particle classification and source attribution.

These results demonstrate that delayed extraction combined with optimized ablation/ionization conditions can enable accurate, high-throughput isotopic measurements in a fieldable instrument, supporting rapid identification and source apportionment of rare particles of interest within complex aerosol backgrounds.

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5IM.7

Application of Broadband Light Scattering to Characterize the Absorption Spectra of Brown Carbon Chromophores Under Supersaturated Conditions. MALSHA AMUGODA, Pedro De Allende, Katelyn Pacaud, Bilal Shokoor, Thomas Preston, James F. Davies, *University of California, Riverside*

The absorption of solar radiation by aerosol particles containing Brown Carbon (BrC) can alter the radiation flux and temperature distribution. Although UV/vis spectroscopy of diluted bulk BrC samples can be used to characterize absorption spectra, these methods can be of limited use when applied to aerosol particles due to high chromophore concentrations and the formation of metastable supersaturated or supercooled states in atmospheric particles. Here, we develop a method to characterize the absorption spectra of levitated aqueous particles in a linear-quadrupole electrodynamic balance (LQ-EDB), allowing us to stably levitate BrC particle alongside purely scattering probe particle, and coupling the LQ-EDB with broadband light scattering spectroscopy consisting of red LED and white LED as the light source allowing the wavelength dependence of the imaginary part of the refractive index, k, to be determined from a single spectrum. We show that a probe particle serves as an effective in-situ probe for the illuminating light and provides a reliable indication of the intensity variation across the measured wavelength range. This allows spectra from sample particles containing light-absorbing components to be referenced and normalized in a way that decouples the processed spectrum from any optical artifacts. Using this approach, we explore the pH-dependent absorption spectra of 4-nitrocatechol particles under a range of relative humidity (RH) conditions. We demonstrate sensitivity to k in the range 0.0001 to 0.01 and compare our results to predictions using bulk UV/vis data. This method allows the characterization of k at much higher chromophore concentrations than traditional UV/vis measurements, enabling a more direct comparison to atmospheric aerosol particles. We further extend this approach to other aqueous BrC systems and examine how surface-active chromophores influence both the measured spectra and the light-absorbing properties of the particles. In future, this technique will facilitate studying the role of high ionic strength and unique phase states on the evolving optical properties of aerosols.

5UA.1 – INVITED

Mapping a Decade of Air Pollution Research in Latin America: A Bibliometric Analysis of Trends, Gaps, and Policy Alignment. Sebastian Larrahondo, JUAN FELIPE FRANCO, *Hill Consulting, Bogota D.C., Colombia*

Air pollution is a major public health concern in Latin America and the Caribbean (LAC), where roughly 172 million people across 366 cities are exposed to fine particulate matter above World Health Organization guidelines, and where locally generated evidence is essential to inform policy. Yet how the region's own scientific research is distributed, and whether it matches the region's health burden, has not previously been assessed across LAC as a whole. We address this gap through a region-wide bibliometric analysis. Using a systematic Scopus and Web of Science search with deduplication and a two-phase relevance screening (regular expressions and a large language model; 94% author agreement), we assembled a corpus of 6,355 publications. We characterized the field along five dimensions: geographic and temporal distribution of research attention (country mentions), alignment with air-pollution burden (Global Burden of Disease disability-adjusted life years), citation impact, thematic structure (keyword co-occurrence), and institutional collaboration. Research attention grew by roughly 78% over the decade but remained highly concentrated: five countries (Brazil, Mexico, Chile, Colombia, and Argentina) accounted for 82.7% of all country mentions, with the field expanding by intensifying study of the same countries rather than broadening across the region. Research attention broadly tracked burden (log-log slope 0.72, R2=0.64), yet under-represented countries (most notably several Central American and Caribbean states) collectively carry about 30% of the region's burden while receiving only about 5% of its research. Citation impact was highly skewed and reflected research volume rather than per-paper influence. Region-scale studies attracted higher per-paper attention than country-specific work. Keyword co-occurrence revealed five interconnected thematic communities centered on particulate matter and health, spanning atmospheric composition, modeling and monitoring, environmental health, neurotoxicity, and the COVID-19 pandemic. Collaboration among the region's own countries was markedly less common than partnership with external, mostly high-income, institutions, and did not strengthen over the decade. Overall, LAC air pollution research is growing but remains geographically concentrated, externally oriented, and unevenly aligned with the region's health burden. Directing research toward high-burden, under-studied countries and strengthening collaboration within the region are key priorities for a more equitable and integrated research field.

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5UA.2

Evolution of Black Carbon Mixing State in the Summertime NY Urban Plume. ADAM DE GROODT, Delphine K. Farmer, Lauren A. Garofalo, John Mak, *Colorado State University*

Black Carbon (BC), a refractory product of incomplete combustion reactions, impacts the climate through radiative forcing and human health via respiratory uptake. In the atmosphere BC mixes with other species which has been shown to enhance its radiative impact. Thus, understanding the evolution of BC mixing state is essential to evaluating the atmospheric impact of the pollutant. With more than 23 million people, the New York Metropolitan Area (NYMA) is an urban landscape with complex chemical emissions. Despite the decreasing trend of BC concentration over the last two decades, the evolution of BC mixing state in the urban plume remains poorly understood. To investigate BC mixing state in the urban plume and the chemical composition of particles we deployed a single-particle soot photometer (SP2) and high-resolution aerosol mass spectrometer (HR-AMS) aboard the NSF/NCAR C-130 aircraft during the Greater New York Oxidant, Trace gas, Halogen, and Aerosol Airborne Mission (GOTHAAM; July-August 2025). Preliminary results suggest that BC becomes more coated as the NY plume ages, with the fraction of thinly coated particles (fthin; < 30% coating by volume) decreasing and thickly coated particles (fthick; > 30%) increasing as we intercepted the plume at multiple locations downwind of NYC through a pseudo-Lagrangian sampling approach. During periods influenced by aged wildfire smoke, fthick increased by a factor of 3 relative to urban air. Thus, while coating thickness grows in the urban plume, transported Canadian wildfire smoke brings the most thickly coated particles, likely having differing impacts on both air quality and human health. Further, both urban and other BC sources can age over the ocean, providing the opportunity to explore fate and evolution of BCCPs. Our observations indicate BCCPs become thickly coated in the urban plume, which will impact the radiative role as well as the lifetime of the particle.

5UA.3

Source Apportionment and Particle Diversity Quantification from Physiochemical Characterization of Individual Particles Collected in the New York City Metropolitan Area. ABBYGAIL AYALA, Yao Xiao, Emily Costa, Kayleigh Reilly, Xu He, Mitchell Rogers, Drew Gentner, Rachel O'Brien, Andrew P. Ault, *University of Michigan*

Single-particle physiochemical characterization captures the heterogeneity of species and therefore properties of aerosol particles, providing vital information to establish sources, improve climate models, and better understand health impacts from air quality. The New York City metropolitan Measurements of Emissions and TransformationS (NYC-METS) field campaign was conducted in the summer of 2023 to evaluate the composition, sources, and aging of atmospheric aerosols in the New York City (NYC) area. This work focuses on the analysis of individual aerosol particles collected from the NYC and generally-downwind coastal Connecticut sites using optical photothermal infrared (O-PTIR) microspectroscopy to obtain functional group information of particles down to ~0.5 µm. Untargeted analysis aided in the identification of 10 unique particle classes based on the dominant infrared-active species present (e.g., biological and dust particles, ammonium sulfate, organic species, and nitrate-containing). Differences in composition were evaluated based on sample location, time of day, and particle size. Particles at the Connecticut site contained more indicators of aging (e.g., sulfate and nitrate) when air masses originated from New York City as compared to air masses from Canada. To probe particle diversity further, variation within these particle classes was assessed using slight spectral differences, such as the presence of esters in biological species and organic content in ammonium sulfate containing particles. Single-frequency O-PTIR images also allowed for the spatial distribution of ammonium sulfate and organics species to be mapped, highlighting another key use of this microspectroscopy technique. This functional group analysis was supplemented with scanning electron microscopy with energy dispersive X-ray (SEM-EDX) spectroscopy to investigate aerosol particle elemental composition. These findings improve the understanding of sources and atmospheric aging of aerosol particles in the New York City metropolitan area by accounting for the diversity of composition at the single-particle level.

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5UA.4

Innovative Methods for Size-Resolved Organic Aerosol Composition Using Offline Aerosol Mass Spectrometry: NYC-METS 2023 Field Campaign. XU HE, Yao Xiao, Ruizhe Liu, Evan Dalton, Mitchell Rogers, Corin Tyler, Emily Costa, Nga Lee Ng, Drew Gentner, Andrew P. Ault, Rachel O'Brien, *University of Michigan*

Urban areas often suffer from high ozone and particulate matter (PM) events, both of which can have negative effects on human health. New York City has periods of high PM concentrations each summer, much of which is formed through secondary processes. To improve our understanding of the changes in the composition and size distribution of urban organic aerosols (OA), 12-hour aerosol particle samples were collected at a ground site in Manhattan during the summer of 2023 as part of the Atmospheric Emissions and Reactions Observed from Megacities to Marine Areas (AEROMMA) campaign using a Micro-Orifice Uniform Deposition Impactor (MOUDI). Samples were characterized with offline aerosol mass spectrometry (AMS) to evaluate the composition of OA as a function of size. A newly developed visualization tool based on delta analysis and delta functional group quantification methods was used to probe size-resolved structural and compositional features under varying air quality conditions. Functional groups vary with aerosol size, with more carboxylic acids in the accumulation mode and more aliphatic groups in the largest (1.0 µm to 5.6 µm) and smallest size (0.056 µm to 0.18 µm) modes. The impact of carbonate components from dust sources on aerosol composition measurements was examined, and a correction approach was developed for offline AMS analysis. Finally, isotopically labeled internal standards were applied to provide advanced insights into organonitrate characterization with offline AMS. Overall, these results are investigating size-resolved chemical composition and will improve our understanding of OA composition and possible sources within megacities as volatile organic compound emissions change.

5UA.5

Status Update and Results from the First Three Years of MAIA's Ground-Based Particulate Matter Monitoring Network. SINA HASHEMINASSAB, David Diner, Jeff Blair, Sabrina Chow, Ann M. Dillner, Yang Liu, Christian L'Orange, Randall Martin, Christopher Oxford, Jeremy A. Sarnat, MAIA Team, *NASA Jet Propulsion Laboratory*

NASA and the Italian Space Agency (ASI) are implementing the Multi-Angle Imager for Aerosols (MAIA) mission to investigate how different types of airborne particulate matter (PM) affect human health. The MAIA satellite instrument, a multi-angle imaging spectropolarimeter, will launch into Earth Orbit in the 2027-2028 timeframe and will be used to retrieve aerosol optical and microphysical properties over 12 Primary Target Areas (PTAs) in North America, South America, Europe, the Middle East, Africa, and Asia. The resulting aerosol products will be combined with ground-based PM measurements and WRF-Chem outputs to produce daily, 1-km-resolution maps of near-surface PM10, PM2.5, and speciated PM2.5 (sulfate, nitrate, organic carbon, elemental carbon, and dust).

MAIA's surface-based PM measurement network is currently operational. It builds on existing monitoring infrastructures and expands coverage in under-monitored regions. The project leverages the SPARTAN network for PM2.5 speciation and incorporated additional AirPhoton samplers, deployed supplementary samplers provided by Colorado State University, and installed AethLabs microAeth MA350 black carbon monitors. In Ethiopia, where PM2.5 monitoring has been historically limited, PurpleAir sensors were deployed to improve ground-based spatial coverage.

This presentation provides an update on MAIA's PM monitoring network and highlights findings from its first three years of operation. Results show elevated PM concentrations at PTAs in low- and middle-income countries (LMICs). IND-Delhi and ETH-AddisAbaba are the most polluted PTAs, with annual average PM2.5 concentrations approaching ~100 µg/m³ and ~30 µg/m³, respectively. PM2.5 chemical composition also varies substantially across PTAs, reflecting regional differences in emission sources, aerosol formation, atmospheric processing, and meteorology. Organic carbon contributes strongly to PM2.5 in several regions (e.g., USA-Atlanta and CHL-Santiago), nitrate fractions are highest in the USA-LosAngeles and KOR-Seoul, elemental carbon is most prominent in Africa (ETH-AddisAbaba and ZAF-Johannesburg), and dust contributes more strongly in arid or dust-influenced regions, including ISR-TelAviv and ESP-Barcelona.

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5UA.6

Temporal Trends in Particulate Air Pollution and Respiratory-Cardiovascular Health Outcomes in Karaganda, Central Kazakhstan. GULDEN ORMANOVA, Philip K. Hopke, Alexey Alexeyev, Alexandra Vinnikova, Sholpan Orazbaeva, Kyran Kasym, *Inst. of New Materials and Energy Tech. PI, Nazarbayev Univ.*

The industrial mining city Karaganda, located in Central Kazakhstan, experiences persistent particulate air pollution. However, longitudinal evidence linking aerosol concentrations with population health remains limited. This study integrated annual air-quality and morbidity datasets for Karaganda city from 2017 to 2024 to evaluate temporal patterns in $PM_{2.5}$, PM_{10}, gaseous co-pollutants, and major respiratory/cardiovascular outcomes. Annual mean $PM_{2.5}$ increased from 75.8 μg m^{-3} in 2017 to 183.3 μg m^{-3} in 2024, with the highest values observed during 2022–2024. PM_{10} showed a similar rise from 74.2 to 189.2 μg m^{-3}, while total suspended dust increased from 119.3 to 205.0 μg m^{-3}. In contrast, SO_2, CO, NO_2, O_3, NH_3, and formaldehyde generally declined or fluctuated without a consistent upward trend. Over the same period, total bronchial asthma cases increased from 279 to 827 (+196%), including a rise among children from 96 to 197 cases. Chronic and unspecified bronchitis/emphysema increased from 207 to 801 cases (+287%), and ischemic heart disease increased from 1,811 to 3,440 cases (+90%). Other cardiac arrhythmias rose from 49 to 296 cases, reaching the highest value in 2024. Exploratory correlation analysis suggested positive associations between $PM_{2.5}$ and bronchial asthma (r = 0.78), childhood asthma (r = 0.79), and other cardiac arrhythmias (r = 0.90), with similar associations for PM_{10}. Pneumonia exhibited a strong anomaly in 2020, likely reflecting pandemic-period effects, and was therefore interpreted cautiously. These findings identify a marked deterioration in particulate pollution in Karaganda and parallel increases in selected respiratory and cardiovascular outcomes. The results support the need for aerosol source apportionment, finer temporal exposure assessment, and targeted public-health interventions in the industrial urban environments of Central Kazakhstan.

5UA.7

Long-Term Trends in Ammonium Nitrate $PM_{2.5}$ Composition and Formation Regime Shifts in the Los Angeles Basin. XIANG LI, Huafang Zhang, *South Coast Air Quality Management District*

Ammonium nitrate (AN) is a major $PM_{2.5}$ component in the Los Angeles (LA) Basin, yet its long-term compositional evolution and the relationship between FRM gravimetric and speciation-based $PM_{2.5}$ mass estimates have not been systematically examined over multiple decades of emission controls. We present a long-term analysis (2000–2024) of U.S. EPA Chemical Speciation Network (CSN) measurements at the South Coast AQMD's Los Angeles Main Street and Rubidoux monitoring sites using nylon filter ion chromatography data. True ambient $PM_{2.5}$ was reconstructed as a direct ion sum (SO_4^{2-} + NO_3^- + NH_4^+ + organic matter + EC + soil + sea salt) without stoichiometric neutralization assumptions, and compared to co-located Federal Reference Method (FRM) gravimetric measurements.

AN averaged 4.4 and 6.6 μg/m^3 at LA Main Street and Rubidoux, comprising 25% and 29% of reconstructed $PM_{2.5}$ — substantially exceeding the ammoniated sulfate fraction (16% and 13%). Both AN concentration and AN fraction declined significantly over the record, yet AN remains the largest inorganic $PM_{2.5}$ component throughout the study period.

FRM gravimetric measurements were on average 3.5% and 5.4% lower than reconstructed $PM_{2.5}$ at LA Main Street and Rubidoux respectively, with this difference increasing over time at LA Main Street. Seasonal analysis revealed distinct site-specific patterns: the difference between FRM and reconstructed mass was largest in winter at LA Main Street (−7.1%) and in summer at Rubidoux (−9.8%), consistent with temperature-dependent partitioning of AN between particle and gas phases during Teflon filter sampling at this hotter inland location.

The aerosol neutralization ratio (NR = measured NH_4^+ / NH_4^+ required to neutralize SO_4^{2-} and NO_3^-) declined at both sites, falling from a range of 0.74 to 0.84 during 2000 through 2012 to a range of 0.47 to 0.53 during 2013 through 2024. The fraction of days exhibiting NO_x-limited AN formation collapsed from 9–19% to less than 2%, indicating a systematic shift toward NH_3-limited aerosol conditions as NO_x emissions declined over the study period.

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5WF.1

The Chemical Complexity of Air Pollutant Emissions from Modern Structural Fires. SHANTANU JATHAR, Kevin Ridgway, Anna Helfrich, Christian L'Orange, Srinidhi Lokesh, Thomas Borch, *Colorado State University*

Wildland-urban-interface (WUI) fires consume modern residential structures, yet current emissions modeling often relies heavily on wildland biomass data, underestimating the complex chemistry of burning structures. To address this gap, the Burning Homes and Structural Materials (BHASMA) campaign quantified gas- and particle-phase emissions from 20 structural fuels and fuel complexes, including lumber, processed wood, roofing, carpet, insulation, plumbing, and flooring, under flaming and pyrolysis conditions across varying fire scales (0.5-500 kW). This study synthesizes results across bulk gases (e.g., CO_2, CO), $PM_{2.5}$ and volatile organic compound (VOC) speciation, polycyclic aromatic hydrocarbons (PAHs), and per- and polyfluoroalkyl substances (PFAS). The results highlight that non-wood-based structural fuels produce higher pollutant emissions compared to traditional wood fuels. Synthetic materials (e.g., carpet, insulation, plumbing) generated up to an order of magnitude higher $PM_{2.5}$, black carbon (BC), and water-insoluble organic aerosols (OA). Similarly, non-wood fuels emitted substantially higher levels of crustal and heavy trace metals, such as copper, chromium, antimony, and tin. Synthetic fuels produced up to ten times greater emissions of single-ring aromatic VOCs, including hazardous air pollutants like benzene and styrene, and five times more emissions of PAHs and PFAS, relative to wood-based fuels. These multi-pollutant insights confirm that modern structural fuels dramatically alter WUI smoke chemistry, elevating exposure risks to highly toxic species.

5WF.2

Particulate and Gas Phase Chlorine Emission Partition of Mixed Fuel Combustion of Polyvinyl Chloride and Medium Density Fiberboard. Thomas Cleary, Aika Davis, Audrey Tombaugh, RYAN FALKENSTEIN-SMITH, *National Institute of Standards and Technology*

Wildland urban interface fire fuel includes complex mixtures of biomass and synthetic fuels, such as polyvinyl chloride (PVC). Mixed fuel cribs consisting of layers of 1.9 cm square sticks of PVC and medium density fiberboard (MDF) were arranged in alternating six-stick layers forming 30 cm cubes. Cribs were constructed with 0, 1, 3, and 6 PVC sticks per 90-stick cribs. Three cribs of each construction were burned in open-flame combustion under a 0.5 MW calorimeter hood in the NIST National Fire Research Laboratory. The hood collects all the smoke from the combustion process and through oxygen consumption calorimetry, the fuel package heat release rate is measured. Laser extinction measurements across the duct along with the duct flow rate characterize the smoke production. Particulate and gas sampling from the duct were analyzed for chlorine content along with un-combusted char and ash residue to perform a mass balance of the chlorine content of the cribs. Gas-phase HCl was measured continuously with a Fourier-transform infrared spectroscopy. Un-combusted PVC and MDF material, particulate and char/ash sample chlorine content was quantified by combustion ion chromatography. Total chlorine recovery for all cribs was nearly 100%, within measurement uncertainty. The average fraction of chlorine as HCl was about 90% for PVC containing cribs. The residue chlorine varied between 6% to 11% of the total chlorine, with the soot fraction averaging about 0.12%. The results show yield measurements of chlorine-containing compounds were consistent with an overall mass balance. The high gas-phase fraction of HCl for the PVC-containing cribs is expected given the predominant dichlorination reaction of PVC. Minor chlorine-containing gaseous species and SVOCs, including chlorinated dioxins, furans, and dioxin-like PCBs, will be identified and quantified in these samples. These experimental results validate the sampling and characterization of chlorine-containing combustion byproducts for fuel package emission characterization.

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5WF.3

Wildland-Urban Interface Fire Emissions from Structural Materials Include Organic-Rich and Polymer-Derived Microplastic Particles. JULIUS ESE, Theodore Tsai, Steven Sharpe, Temitope Olayemi, Seth Koloski, Ryan Moffet, Matthew Fraund, Alexander Laskin, *Purdue University*

Wildland–urban interface (WUI) fires generate aerosols resulting from the burning of both biomass and structural materials, yet the chemistry of particles emitted from these structural materials remains poorly constrained. In this work, scanning transmission X-ray microscopy coupled with near-edge X-ray absorption fine structure (STXM–NEXAFS) was used to characterize the composition, internal mixing state, and carbon speciation of individual particles produced during controlled flaming and pyrolytic burning conditions of representative material present in WUI fires. Pyrolysis produced predominantly highly organic, compositionally homogeneous particles with organic volume fraction (OVF) distributions strongly skewed toward 0.8–1.0, whereas flaming generated broader OVF distributions. Cluster analysis of the carbon K-edge NEXAFS spectra identified four particle classes, including polymer-associated classes in polyester-derived particles. One class showed similarity to polymer micro and nanoparticles (MNPs) reported in the literature, suggesting direct atmospheric emissions of MNPs resembling polymer composition of the parent construction material, whereas other polymer-associated particles were more consistent with the flaming-associated soot-like particle cluster observed in this study. These results show that the burning conditions strongly influence particle composition and mixing state. Overall, this work advances understanding of particulate matter emitted by WUI fires, an increasingly important and understudied source of air pollution, and helps address key uncertainties in the representation of WUI fire aerosol emissions in air quality and climate models

5WF.4

Characterization of Plastic-Burning Particulate Matter Generated Through Pyrolysis and Flaming Combustion. B. SAGE LAUPER-COOK, Lena Gerritz, Aleksei Noskov, Dmitry Fishman, Sergey Nizkorodov, Manabu Shiraiwa, *University of California, Irvine*

Plastic burning as a means for waste treatment causes substantial generation of particulate matter (PM) and microplastics into the atmosphere. The chemical composition and health effects of these combustion products are not well understood. Reactive oxygen species (ROS) can cause oxidative stress upon inhalation and deposition of the PM into the lungs. A previous study has shown that plastic burning PM generated by flaming combustion produces ROS in the aqueous phase; however, there has been no work investigating the ROS generated by plastic burning with pyrolysis. We characterized the chemical composition of plastic burning PM generated through controlled pyrolysis and flaming of HDPE, LDPE, PP, PC, and PVC, using mass spectrometry and attenuated total reflection Fourier transform infrared, Raman, and electron paramagnetic resonance spectroscopy. Here we characterized plastic-burning PM, demonstrating that flaming generates more oxidized, aromatic species, while pyrolysis generates larger oligomeric fragments. We detected and characterized microplastics generated through both combustion methods, finding a higher fluorescence intensity and carbonyl index through flaming, indicating greater oxidation and degradation in the presence of air. We also conducted measurements of ROS (•OH, $•O_2^-$/$•HO_2$, organic radicals) and oxidative potential (•OH and DTT assay) in aqueous extracts of plastic burning PM generated through pyrolysis and flaming in air. These results will allow for greater understanding of ROS multiphase chemistry by plastic burning PM and a more complete picture of the health relevant properties of pyrolysis.

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5WF.5

Emissions of Gaseous and Particulate Speciated Organics from Combustion of Furnished Structures. MICHAEL MILAZZO, Nathan Kreisberg, Robert Weber, Bryce Bathras, Wuquan Cui, Lindsay Yee, Michael Gollner, Allen Goldstein, *University of California, Berkeley*

The number of structures destroyed in fires has increased in recent decades due to the growing prevalence of communities at the wildland-urban interface (WUI) and the increasing severity of wildland fires. Recent research has investigated WUI fire emissions from the combustion of individual anthropogenic fuels and from environmental effects after WUI fires like the 2025 Los Angeles Fires. However, there is a lack of research into the emissions from controlled combustion of larger mixed entities like burning structures. We participated in a series of experiments in which Accessory Dwelling Units (ADU) were ignited to assess structure-to-structure fire spread. These ADUs were built to California Building Code Standards, plumbed and wired for use, and furnished with regular household amenities including appliances, a bathroom, a couch, and clothes.

The bulk emissions from a burning ADU were sampled via a custom sampling package aboard a drone which followed the plume throughout the experiment. Online measurements of CO and CO_2 provided quantification of modified combustion efficiency (MCE). Time-integrated samples of particulate matter provided measurements of total $PM_{2.5}$, organic carbon (OC), elemental carbon (EC), and speciated elemental analysis by ICP-MS. Samples of volatile organic compounds (VOCs) and organic aerosol (OA) provided speciated organic composition by thermal desorption comprehensive two-dimensional gas chromatography with high-resolution time-of-flight mass spectrometry.

Here, we present CO_2-based emission factors (EFs) of speciated gas- and particle-phase organics from the combustion of seven ADUs. We summarize organics by compound class and identify key species that could serve as WUI fire tracers. We contextualize observations with MCE, building material and notable events. For example, EC emission factors correlated well with MCE and peaked early during each test, while OC EFs were highest during peak heat release and residue burning at the end of tests. We assess correlations between EFs to identify common source profiles.

5WF.6

Measurements of Smoke Emissions from Interior and Exterior Structural Fires in the Wildland Urban Interface. THOMAS CARROLL, Muhammad Abdurrahman, Michael Caraway, Nicholas Kusumo, Kruthika Kumar, Anita Anosike, Mac A. Callaham, Joseph O'Brien, Ed Fortner, Webster Marshall, Kathryn Zimmerman, Rawad Saleh, *University of Georgia*

Wildland-Urban Interface (WUI) fires are increasing in severity and frequency, yet their emission profile is poorly characterized. During the second Georgia Wildland-fire Simulation Experiment (G-WISE-2), we simulated typical American structural house fires using a scaled-down fuel package that included carpet, plywood, insulating foam, and plastics. We quantified the emission factors of carbon dioxide (CO2), carbon monoxide (CO), nitrogen oxides (NOx), organic carbon (OC), elemental carbon (EC), and heavy metals, as well as the formation of secondary organic aerosol (SOA) due to photochemical aging. We burned the same fuel package inside and outside of a live-fire apparatus to simulate interior fires (the fire occurs inside the structure with the structure intact) and exterior fires (fuels burn outside of a structure or the structure is no longer intact; thus, the fire occurs in the open atmosphere).

Interior fires produced comparable CO (50.24 g/kg-fuel vs. 49.35 g/kg-fuel) and NOx (3.78 g/kg-fuel vs. 3.58 g/kg-fuel), less OC (4.48 g/kg-fuel vs. 4.96 g/kg-fuel) and heavy metals (6.04 mg/kg-fuel vs. 7.71 mg/kg-fuel), but more CO2 (3,645 g/kg-fuel vs. 1,667 g/kg-fuel), EC (5.91 g/kg-fuel vs. 4.54 g/kg-fuel) and OA enhancement due to SOA formation (20.62% vs. 12.64%). We attribute these differences to variations in combustion conditions, with interior fires experiencing more efficient combustion than the exterior fire, manifested as higher modified combustion efficiency (0.99 vs. 0.97) and EC/OC (1.40 vs. 0.92).

When compared to emissions from simulated wildland fires, the contrast was pronounced. Structural fires produced significantly less CO and SOA, and an order of magnitude less OC, but significantly more CO2 and an order of magnitude more EC and NOx. These findings underscore the importance of distinguishing between emissions from structural and wildland fuels in WUI fires, with implications for firefighter health.

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5WF.7

Characterization of Metals in Particulate Matter Emissions from Structure Fire Fuel Packages. AIKA DAVIS, Thomas Cleary, Ryan Falkenstein-Smith, Michael Link, Audrey Tombaugh, *National Institute of Standards and Technology*

Emissions from full structure burns are not yet well characterized. In addition, some studies have found elevated levels of metals and metalloids in wildland-urban interface fire ash. We have conducted a study to characterize particulate emission yields from construction materials in a stacked array to mimic a structure. The mixed fuel cribs (1 ft on each side, constructed in a cube) consisted of sticks of wood, gypsum board, OSB, polyester, polyurethane, polyvinyl chloride, polystyrene, polyisocyanurate, and shingles. Some cribs included aluminum, copper, and galvanized steel inside.

The cribs were burned under oxygen consumption calorimeters to measure mass loss, heat release rate, and other combustion characteristic measurements throughout each test. The calorimeter's exhaust hood captured the fire plume, and smoke samples were continuously collected from the exhaust duct at a well-mixed location for the test duration. Sampling pumps pulled smoke samples from the duct through a probe onto a 47.0 mm quartz filter at 3 LPM, and a bypass pump to adjust the flow to meet isokinetic sampling conditions. A portion of the filters was digested, then analyzed by inductively coupled plasma mass spectrometry for metals. The other section of the filters was directly desorbed by a thermal desorption unit and analyzed by gas chromatography-mass spectrometry (GC-MS) for particulate-phase SVOC analysis (including PAHs and select chlorinated dioxins and furans). The talk will discuss details of the experiments, burn behavior, metal content in the collected particulate matter, and particle-phase SVOC emission yields of the four different crib constructions.

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6AC.1

An Aerosolomics Approach to Characterizing Biomass Burning Emissions – Application to Indian Crop Residue Burning. CHU-WEN CHENG, Roshan Kumar Singh, Ran Zhao, *University of Alberta*

The “omics” describes the approach to analyze the entirety of sample composition, such as metabolomics and proteomics. In recent years, Aerosolomics, which focuses on aerosols, has emerged as a new approach for characterizing the complex organic aerosol composition. Biomass burning organic aerosol (BBOA) comprises a highly complex mixture whose chemical profile heavily depends on fuel type and combustion conditions. However, the lack of standardized non-targeted analytical workflows currently hinders accurate comparisons across fuels and sample types. This study aims to 1) establish a comprehensive aerosolomics workflow—encompassing sample collection, preparation, measurement, and data analysis—for BBOA, and 2) apply this approach to characterize freshly emitted smoke from wood and Indian crop residues.

Our aerosolomics pipeline primarily utilizes liquid chromatography-high-resolution mass spectrometry (LC-HRMS) to analyze BBOA filter samples collected from a tube furnace and controlled laboratory burning with low-volume and sonication-free extractions. The data were first processed with MZmine software and an in-house Python program for further processing and analysis.

For the freshly emitted smoke, principal component analysis (PCA) of in-lab open burns demonstrated distinct chemical clustering based on fuel type, successfully differentiating the chemical profiles of various crop residues. Furthermore, clear separation was observed between the semi-volatile organic compound (SVOC) and combined particulate matter (PM) + SVOC fractions, emphasizing the method's capability to capture phase-dependent chemical complexity. Notably, integrating different temperature settings in the tube furnace produced molecular peaks aligned with those from controlled burning, providing evidence that the tube furnace can be a viable sample generation tool with noted differences in chemical species composition. This work pave ways for a more streamlined and standardized workflow for aerosolomics analysis for BBOA using LC-HRMS. Future work will focus on cross-comparison between fire samples, such as wildfire versus crop residues, identifying fuel-specific tracers, and constructing a comprehensive database to improve atmospheric source apportionment.

6AC.2

Temperature-Driven Regimes of Biomass Burning Aerosol Formation. ZEZHEN CHENG, Gregory W. Vandergrift, Valentina Sola, Sijia Liu, Ryan Poland, Michael Caraway, Schuyler Lockwood, Tania Gautam, Amna Ijaz, Yuzhi Chen, John Shilling, Nurun Nahar Lata, Sining Niu, Jing Li, Matthew A. Marcus, Payton Beeler, Laura Fierce, Gourihar Kulkarni, Alexander Laskin, Sergey Nizkorodov, Geoffrey Smith, Rawad Saleh, ManishKumar Shrivastava, Alla Zelenyuk, Swarup China, *Pacific Northwest National Laboratory*

Biomass burning aerosols (BBA) have important but poorly constrained impacts on the Earth system, partly because their formation pathways and physicochemical properties remain incompletely understood. Here, we conducted the Study of Molecular, Optical, and Kinetic properties of combustion Emissions (SMOKE) Campaign at the Environmental Molecular Sciences Laboratory to investigate BBA generated from pine needle combustion at 300, 400, 600, and 900 °C under a constant air-to-fuel ratio. Here, we propose three temperature-dependent regimes of BBA formation. Pine needle combustion at 300 °C and 400 °C falls within Regime I, a low-temperature organic-condensation regime in which biomass volatilization/pyrolysis produces relatively oxygen-rich vapors that condense into organic-rich particles. Individual-particle and molecular analyses show that particles emitted in this regime exhibit similar chemical and physical properties, and all particles are liquid-like oxygen-rich organics. Pine needle combustion at 600 °C falls within Regime II, a transition regime characterized by enhanced thermochemical processing. Compared with particles at Regime I, organic particles at 600 °C are relatively more viscous and exhibit semisolid- and solid-like phase states, more frequently internally mixed with inorganics, contain larger PAHs, and exhibit a lower O:C ratio, higher sp^2 fraction, higher double-bond equivalent, and higher modified aromaticity index. Molecular formula-level transformation analysis suggests that this transition reflects chemical transformation pathways involving oxygen loss, hydrogen loss, aromatization, and multi-step C_2H_2-addition/H-loss patterns. These findings indicate substantial maturation toward soot-like carbon, consistent with the concept of a brown-to-black carbon continuum. Pine needle combustion at 900 °C is within Regime III, representing a high-temperature refractory/flame regime, where aerosol composition shifts toward refractory particles, including fly ash, ultrafine amorphous organic–inorganic spheres, tar ball, and soot. This three-regime framework links combustion temperature to BBA composition, mixing state, phase state, and optical properties, supporting future parameterizations of BBA impacts in atmospheric models.

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6AC.3

Aerosol Uptake of NO_3 Dominates Nighttime NOx Loss in Wildfire Smoke. ZHANCONG LIANG, Jonathan Abbatt, *University of Toronto*

Nighttime nitrogen oxide chemistry is conventionally viewed through the reactive uptake of N_2O_5, which converts NO_x into nitric acid and particulate nitrate. This framework assumes that N_2O_5 loss is controlled primarily by its own multiphase hydrolysis, whereas the coupled role of nitrate radical (NO_3) uptake remains poorly constrained. Herein, we show that biomass-burning organic aerosol (BBOA), a major component of wildfire smoke, redirects nocturnal reactive nitrogen loss through rapid NO_3 uptake. Using an aerosol flow reactor with systematic variation of NO_2, which shifts the NO_3/N_2O_5 equilibrium, we find that apparent N_2O_5 decay accelerates strongly at lower NO_2 mixing ratios where the NO_3/N_2O_5 ratio is high. Coupled kinetic modelling resolves this behavior into weak direct N_2O_5 uptake with γN_2O_5 of 10^{-4} to 10^{-3}, and much faster NO_3 uptake, with γNO_3 above 0.2 at 25-71% RH at room temperature. Particle characterization further shows that this pathway converts reactive nitrogen into light-absorbing organonitrogen products rather than classical inorganic nitrate via N_2O_5 hydrolysis. Together, these results identify wildfire aerosols as an active nocturnal chemical interface that links nighttime NO_x loss to organonitrogen formation, with implications for subsequent oxidant chemistry and the optical and health impacts of smoke.

6AC.4

Nighttime Formation and Photochemical Evolution of Nitroaromatics and Organonitrates from Biomass-Burning Derived Phenolic Compounds. David Pando Gonzalez, Madeleine Sze In Ng, Siqi Wang, Rodney J. Weber, NGA LEE NG, *California Institute of Technology*

Biomass burning is an increasing source of phenolic volatile organic compounds (VOCs) that undergo oxidation in the atmosphere to form secondary organic aerosol (SOA). Among these VOCs, phenol, guaiacol, and syringol have the highest emission factors, which have been shown to produce nitrogen-containing compounds (CHON) upon nighttime nitrate radical oxidation, contributing to light-absorbing brown carbon (BrC). While previous chamber studies probed single-oxidant oxidation under dry conditions, atmospheric plumes can experience diel transition of oxidants and elevated relative humidity (RH) which facilitates multiphase oxidation. Here, we investigate night-to-day oxidation of these VOCs using the Georgia Tech Environmental Chamber under high RH (65 %). We combine real-time chemical composition measurements from high-resolution mass spectrometers with volatility and optical properties characterization to elucidate how these systems age in diel oxidation.

Our findings show that phenolic systems evolve with different dynamics depending on the parent VOC structure, producing organonitrates (ONs) or light-absorbing nitroaromatics (ArNO2). Despite their overlapping molecular formulas, these CHON compounds show distinctive time evolution, volatility, fragmentation pattern, and optical properties. For phenol, nitrate radical oxidation initially forms BrC associated with ArNO2 products such as nitrophenol, but after phenol is depleted, BrC signal decays while lower-volatility, light-scattering ONs emerge from oxidation of high-generation products. Sequential daytime UV exposure drives rapid decomposition of ONs, while ArNO2, BrC, and SOA masses increase significantly. This photochemical BrC enhancement is strongest for phenol but weakens with methoxy group substitution. These results highlight the diversity of biomass burning-derived CHON, in which the distribution between ArNO2 and ONs controls reactive nitrogen cycling and BrC evolution, providing new insights into how photochemical plume aging influences BrC and how diel oxidation affects downwind air quality.

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6AC.5

Airborne Microplastics Are an Unexpected Source of Atmospheric Brown Carbon. Yangyang Liu, GABRIEL ISAACMAN-VANWERTZ, Peter Vikesland, *Virginia Tech*

Microplastics are increasingly recognized as emergent atmospheric contaminants, yet they are generally presumed to be insignificant contributors to atmospheric chemistry. Here, we show that solar irradiation transforms ten common airborne microplastics into nanoplastics and brown carbon (BrC) in the presence of globally ubiquitous nitrate aerosols. Strong interfacial electric fields at the nitrate aerosol surface promote the production of reactive species that accelerate microplastic aging and produce strongly absorbing products with mean mass absorption coefficients approaching ~1 m^2 g^{-1}. These results illustrate the overlooked radiative effect of ever-increasing concentrations of airborne microplastics and their impacts on climate change.

6AC.6

Photochemical Evolution Upon Irradiation of Primary Brown Carbon with Varying Sources and Concentrations. SITHUMI LIYANAGE, Colton Calvert, Holly Anthony, Gwendolyn Copland, Elijah Schnitzler, *Oklahoma State University*

Brown carbon (BrC) components of biomass-burning organic aerosol (BBOA) undergo dynamic photochemical transformations that influence their optical properties and climate-relevant radiative effects. This study integrates two approaches to investigate the photochemical evolution of BrC: (i) the concentration-dependent behavior of primary BrC generated from eastern red cedar sapwood under irradiation, and (ii) a comparative analysis of BrC from four tallgrass species, motivated by the regional relevance of grassfires, which are understudied as sources of biomass-burning emissions. Together, these experiments elucidate how both source composition and concentration govern the balance between photo-enhancement and photobleaching. Primary BrC samples were generated through controlled biomass-burning experiments using a quartz tube furnace, followed by extraction with solvents. A concentration series of BrC was prepared in ultrapure water to determine the efficiency of absorption enhancement and singlet oxygen ($^1O_2$) generation, determined by reaction with a chemical probe, upon irradiation. The lowest BrC concentration exhibited the most rapid initial absorption enhancement and the highest quantum yield, while higher concentrations showed significantly lower values, indicating lower photochemical efficiency under concentrated aerosol conditions than dilute cloud conditions. For the tallgrasses, BrC extracts from the four species were prepared using acetonitrile as the solvent to determine initial optical properties and compared to primary BrC from other sources. The grasses exhibited very similar initial optical properties, including mass absorption coefficient (MAC) and absorption Angstrom exponent (AAE), but differing time series of relative absorbance upon irradiation at the same concentration. Together, this work demonstrates that the photochemical lifecycle of primary BrC is highly concentration- and source-dependent, with important implications for its atmospheric lifetime, optical evolution, and contribution to radiative forcing.

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6AC.7

Salt-Dependent Singlet Oxygen Oxidation of Biomass-Burning Furans in Aerosol Liquid Water. ANTAI ZHANG, Christopher Niedek, Wenqing Jiang, Mallory Liebes, Kyle Moore, Cort Anastasio, Qi Zhang, *University of California, Davis*

Furans are an important class of oxygenated volatile organic compounds emitted from biomass burning. Because of their high reactivity and water solubility, furan compounds can undergo rapid aqueous-phase oxidation in atmospheric droplets and aerosol liquid water (ALW), contributing to the formation of secondary organic aerosol (SOA). Singlet oxygen ($^1O_2$) is a selective aqueous-phase oxidant for electron-rich furan compounds, but its reaction kinetics in concentrated, salt-rich aerosol liquid water (ALW) remain poorly constrained.

In this study, we investigated $^1O_2$-mediated oxidation of furfuryl alcohol (FFA) and 2-methylfuran-3,4-dicarboxylic acid (MFDCA) as model furan compounds under ALW-relevant salt-rich conditions. Reaction rates were measured under controlled illumination with varying concentrations of ammonium sulfate, lithium chloride, and sodium chloride with ionic strength ranging from 0-12 M. Perinaphthenone (PN), rose bengal (RB), methylene blue (MB), and ambient particulate matter extract (PME) were used as photosensitizers to generate $^1O_2$ and to evaluate how inorganic ions and photosensitizer identity influence $^1O_2$ production and furan oxidation.

We observed strong photosensitizer-dependent salt effects. PN-sensitized reactions showed substantially enhanced oxidation rates with increasing salt concentration, whereas RB- and MB-sensitized reactions were generally suppressed, with the magnitude of enhancement or suppression varying by salt type. In contrast, PME-sensitized reactions generally increased with ionic strength, suggesting that complex atmospheric particulate mixtures can exhibit salt effect that differ from those of individual ionic photosensitizers. These results indicate that inorganic ions regulate $^1O_2$-mediated furan oxidation through coupled effects on $^1O_2$ production, the effective rate constants for $^1O_2$-furan reaction, and ion-specific interactions among salts, photosensitizers, and furan substrates. Overall, this work highlights the important role of ALW composition in controlling aqueous-phase oxidation kinetics relevant to biomass-burning SOA formation and evolution.

6AC.8

Superoxide Burst Upon Photochemical Aging of Secondary Organic Aerosols Derived from Biomass Burning Precursors. Lena Gerritz, Meredith Schervish, Pascale Lakey, Sergey Nizkorodov, MANABU SHIRAIWA, *University of California, Irvine*

Photochemical oxidation in the aqueous phase is critical for chemical evolution of secondary organic aerosols (SOA), but it represents one of the most uncertain processes in aerosols and clouds. Here we show that photoirradiation of SOA derived from biomass burning precursors leads to a burst of superoxide. The combination of laboratory measurements and kinetic modeling reveals that superoxide generation is driven by photosensitization reactions in aromatic SOA, while the dominant source of superoxide in biogenic SOA is photo-induced decomposition of carbonyls with minor contributions from peroxide decomposition. The superoxide burst serves as a substantial source of reactive oxygen species (ROS) including hydrogen peroxide and hydroxyl radical in cloud droplets and deliquesced particles, competing with traditional sources such as uptake from the gas phase. This unconstrained source of ROS will enhance the impact of aqueous-phase processing on composition and properties of aerosols and clouds.

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6CO.1

Continuing Role of Particulate Sulfate Mass Emissions Across Fuel-Type and Lean Combustor Engines. BENJAMIN A. NAULT, Andrew Freedman, Ed Fortner, Anandi Williams, Bruce Anderson, Steven Baughcum, Matthew Brown, Josh DiGangi, Francisco Guzman, Jennifer Klettlinger, Michael Shook, Gregory Smallwood, Elizabeth Wiggins, Edward Winstead, Luke Ziemba, Richard Miake-Lye, Richard Moore, Francesca Gallo, *Aerodyne Research, Inc.*

Emissions of particulate matter (PM) from aircraft engines impacts climate through direct scattering and formation of contrails and air quality near airports. Improvements in engine technology and fuel composition have impacted the emissions of PM, leading to high uncertainty in predicting the contrail formation from aircraft engines. Ground-based observations of PM emissions from different aircraft engines, including lean, staged-combustor engines, with different fuel types, including sustainable paraffinic kerosene sustainable aviation fuel and a very low sulfur Jet-A, were sampled across two years as part of the Boeing ecoDemonstrator project. The observed maximum sulfate mass concentration during both years was up to 2-orders of magnitude lower than observed in prior studies using Jet-A with higher fuel sulfur content, and the observed sulfate mass concentration was similar to the observed background sulfate. This led to the importance of having well defined sulfate background for improved calculations of the sulfate emission index (EI_{SO4}). For 2022, the EI_{SO4} ranged from limit of quantification (~0.02 mg kg^{-1}) to ~1.2 mg kg^{-1}, with local Jet-A typically having the highest EI_{SO4}. Higher than expected values were also observed for lower sulfur content fuels, potentially indicating the presence of residual Jet-A and/or limits in fuel sulfur quantification. The 2023 study had significantly lower EI_{SO4}, ranging between limit of quantification to ~0.3 mg kg^{-1}, suggesting better fuel handling than 2022. Though the EI_{SO4} during ecoDemonstrator was similar to prior studies even though prior studies had higher fuel sulfur content, we suggest the emissions and surface area from black carbon has an important impact on the apparent EI_{SO4}. The results are placed into the context of potential impact towards contrail formation from black carbon as potential importance of new particle formation versus particle condensation for sulfate.

6CO.2

Particle Emission Property from Small Gas Turbine with SAF. HIROYUKI YAMADA, Toshiki Kaneko, *Tokyo Denki University Graduate School*

Particle emissions from a small gas turbine engine has been measured. For fuels, adding to traditional jet fuel (Jet A-1), Sustainable Aviation Fuels (SAF) such as Hydrotreated Esters and Fatty Acids (HEFA), Catalytic Hydrothermolysis Jet (CHJ) and Alcohol To Jet (ATJ) were tested. The gas turbine engine used in this study was small (maximum power of 210 N). However, a particle number emission factor of the tested engine, observed by a device adopted with aviation gas turbine engine certification, was similar with those of a real jet engine used for aviation. Results with SAF show liner correlation between solid particle number emissions and aromatics contents in fuels.

Size distribution measurements with and without a catalytic stripper which oxidize volatile particles suggested that the exhaust particles are consists of small solid particles enlarged by volatile particles and truly volatile particles.

Simulations with Ansys CHEMKIN PRO were also performed to understand the effect of fuel on particle emissions.

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6CO.3

Aircraft Engine Emissions: The Changing Aerosol Composition with the Transition from Fossil Jet Fuels to Sustainable Aviation Fuels (SAFs). ONYINYE A. EZEIFEKA, Yevgen Nazarenko, *University of Cincinnati*

Aircraft ground operations generate particle emissions that contribute to occupational exposure among aviation workers. As the aviation industry transitions from conventional fossil-based jet fuels to sustainable aviation fuels (SAFs), understanding how this shift alters combustion-derived aerosol emissions is critical for evaluating implications for worker health. Experimental studies systematically comparing particle emission profiles between Jet A and SAF across controlled engine operating regimes remain limited. This study characterized and compared particle emissions from Jet A and SAF combustion using a laboratory-scale combustor under systematically varied conditions representative of aircraft engine operating modes. Four equivalence ratio conditions (ϕ = 0.7, 1.0, 1.3, and 1.6), approximating idle, taxi, and high-power operating regimes, were evaluated while maintaining constant temperature (150 °C), chamber pressure (2 atm), and air flow rate (3.915 g/s). Exhaust was diluted with 30 L/min of air using a mass flow controller. Particle size distribution and number concentration were characterized using a Fast Mobility Particle Sizer (FMPS), a Scanning Mobility Particle Sizer (SMPS), and an Optical Particle Sizer (OPS), enabling resolution of both ultrafine and coarse particle fractions. Statistical comparisons across conditions and fuel types were performed using Kruskal-Wallis analysis with Dunn-Bonferroni post hoc correction. Across all Jet A conditions, emissions were dominated by ultrafine particles (<100 nm), with the lean condition (ϕ = 0.7) yielding the highest particle number concentrations and unimodal size distributions peaking in the 15-30 nm range, consistent with nucleation-mode particle formation. Comparative evaluation with SAF is ongoing and will be presented. Based on SAF's reduced aromatic content relative to Jet A, lower ultrafine particle concentrations in the emissions are anticipated. The findings will inform fuel formulation and selection, occupational exposure assessment, and exposure control strategies to reduce inhalation exposure of aviation ground personnel to toxic aerosol emissions from aircraft as a result of the transition to more extensive use of sustainable aviation fuels.

6CO.4

Getting the Lead Out: A Case Study of a General Aviation Airport in San José, California. Somalia Perkins, Frederick McVeigh Lopez, Lupita D. Montoya, Eric Peterson, SHERYL EHRMAN, *San José State University*

The top source of airborne lead in particulate matter in the United States is emissions from piston engine aircraft (PEA). Leaded gasoline has been banned in the US since 1996 for health reasons, but most PEA in the US are still fueled with leaded aviation gasoline (avgas), posing health risks to residents near general aviation (GA) airports. In 2021, a study of blood lead levels in children living near Reid Hillview Airport (RHV) in San José, CA, showed a correlation between proximity to RHV and increased blood lead levels. In 2022, Santa Clara County became the first US county to discontinue the sale of leaded avgas and transition to selling only unleaded aviation fuel at its two airports, Reid-Hillview and San Martin. The available fuel was 94 octane (UL94), produced by Swift Fuels. Review of fuel delivery records for RHV indicated that sales of UL94 unleaded avgas were modest in 2022 but increased from 2023 onward. Analysis of airborne lead concentrations (2012-2024) in total suspended particulate (TSP), showed that the amount of airborne lead in TSP versus the number of daily airport operations was significantly reduced; annual reductions continue as more pilots select unleaded fuel and more GA airports make it available. Analysis of daily airport operations for RHV and nearby GA airports further indicate that, except for 2020, traffic at RHV was lower than in years before 2022. A higher (100-octane) unleaded avgas (G100), produced by GAMI, was made available in October 2024; however, sales of this fuel have not picked up. Work is underway to analyze the Tower landing information from RHV to determine whether PEA that require higher octane fuel are shifting away from using RHV, potentially shifting lead emissions to other GA airport sites.

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6CO.5

PM2.5 Chemical Evolution During an Industrial Pool Chemical Fire: The 2024 Biolab Event in Atlanta. SOHYEON JEON, Ruizhe Liu, Can Barut, Nga Lee Ng, *Georgia Institute of Technology*

On September 29, 2024, a fire broke out at a pool chemical facility (BioLab) in Conyers, Georgia. It released a toxic plume, forcing more than 17,000 residents to evacuate. The combustion of chlorine- and bromine-rich chemicals released a significant amount of chlorine-, bromine-, and reactive-nitrogen-containing gas phase products. However, the impacts of the pool chemical fire on ambient aerosol level, composition, and properties remain largely unexplored. In this study, we investigate changes in PM2.5 composition associated with the plume at the Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT) site in Atlanta, located ~23 km away from the fire, using Aerosol Chemical Speciation Monitor (ACSM), Aethelometer (AE33), Xact, and Scanning Mobility Particle Sizer (SMPS). We observed substantial increases in chloride (x405), ammonium (x15), nitrate (x13), and organics (x10) relative to the background levels. The anion/cation ratio shifted from ~0.7 (background) to ~1 (plume period), indicating enhanced neutralization. This transition was primarily driven by the formation of NH4Cl, followed by NH4NO3 and accompanied by a sharp increase in aerosol liquid water content (ALWC) (x18). These results indicate that pool chemical fires can significantly enhance secondary inorganic aerosol formation, potentially via pathways of heterogeneous reactions such as HNCO hydrolysis and ClNO2 production on chloride-containing particles, followed by subsequent reactions. Additionally, positive matrix factorization (PMF) analysis identified a unique factor containing cyanuric acid (CYA), a stabilizer in chlorinated pool chemicals and an EPA-listed drinking water pollutant with known health concerns. Overall, these findings suggest that pool chemical fires can elevate potential health risks by changing aerosol composition and properties, underscoring the value of real-time speciated PM2.5 chemical composition measurements for assessing exposure impacts.

6CO.6

Characterization of Vehicle Originated Condensable Particulate Matter. GIWON KANG, Jeongbeen Kim, Soodong Lee, Changhyuk Kim, *Pusan National University*

Condensable Particulate Matter (CPM) is primary nanoparticle aerosol formed through rapid condensational phase transition due to temperature drop after being emitted to the atmosphere as gas-phase pollutant. Stationary CPM sources, such as coal-fired power plants, so far have been extensively characterized. However, the contribution of internal combustion engine vehicles (ICEVs) still requires further evaluation, even though ICEVs produce significantly high concentrations of ultrafine CPM (< 100 nm). The ultrafine CPM can deeply penetrate into alveolar regions, causing human health problems. Therefore, comprehensively characterizing ICEV-derived CPM is essential for sustainable urban air quality and public health. In this study, CPM originated from 8 types of vehicles has been characterized using a novel real-time CPM measurement system (PNU-CPM system) and off-line physicochemical analyses. Emission factors of CPM were determined by the PNU-CPM system for different kinds of fuels. The particle morphology was analyzed using the filter samples by scanning electron microscopy. Thermal desorption-gas chromatography-mass spectrometry was used to analyze the chemical composition of the CPM particles. In addition, ion chromatography and inductively coupled plasma-optical emission spectrometry were employed to analyze the inorganic components. The diesel vehicle without after-treatment system emitted the largest amount of CPM and Total PM, i.e., the CPM percentage were about 63%, 8% and 59% for diesel, gasoline, and gas vehicles, respectively. The organic components of CPM were primarily composed of alkanes (~53.5%) and esters (~5.1%), varied according to the tested ICEVs. The major water-soluble ions of CPM were SO42- and Na+. The MPPD model simulation showed that the mass rate per weight of deposited particles in lungs for child were the highest in different age groups. This implies that heavy exposure to CPM emitted from vehicles can cause adverse health impacts and diseases more in children than adults.

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6CO.7

Quantitative Soot Yield (QSY) of Fuel Surrogate Components in Ethylene Counterflow Diffusion Flames. CHRISTIAN P. BJORK, Alessandro Gomez, Francesco Carbone, *Yale University*

Soot emissions from combustion pose significant hazards to human health and the environment, necessitating quantitative metrics for the sooting tendency of practical fuels. This work focuses on a doping-based approach for the assessment of the Quantitative Soot Yield (*QSY*) of fuels in Counterflow Diffusion Flames (CDFs), based on inexpensive pyrometry measurements of soot volume fraction and simple computational modeling. The determination of *QSY* is extended to several ethylene CDFs spanning peak flame temperatures (T_{max}) of several hundred Kelvin, at two different stoichiometric mixture fractions (Z_{st}), and doped with either of two prevaporized liquid fuels, 900 or 1500 ppm of 1,2,4-trimethylbenzene (TMB_4) or 1500 ppm n-decane (nC10), so that the fundamental structure of the base flame is minimally altered. The *global QSY* is demonstrated to be independent of doping level for TMB_4, indicating the robust nature of the doping approach, logarithmically linear with T_{max}, implying Arrhenius-type overall chemistry, and quantitatively verifies a TMB_4>nC10>C_2H_4 hierarchy of sooting tendency, consistent with existing qualitative indices (e.g., TSI and YSI). In addition to the *global QSY*, a *local QSY* (QSY_l) is introduced in the ethylene flames, which is a function of local temperature and accounts for changes in the local mass fraction of carbon (Y_C). The QSY_l reveals a 70 kcal/mol activation energy for high-temperature (>1600K) Arrhenius-type soot formation in ethylene flames, and a first-order dependence on Y_C, independent of T_{max} and Z_{st}. Additionally, QSY_l justifies a robust method for decoupling the sooting contributions of the base C_2H_4 fuel and dopant(s). The introduction of QSY_l enables a simple yet accurate soot formation mechanism for implementation in models, and the ability to measure the *global QSY* of pre-vaporized liquid fuels opens the door for the quantitative assessment of the sooting tendency of practical fuels like jet fuels, synthetic aviation fuels, and their surrogates.

6CO.8

Characterization of First-Generation OH Oxidation Products of Phenolic VOCs in the Gas Phase. WILLIAM RAGEN, Zachary Deininger, Haofei Zhang, *University of California, Riverside*

Phenolic VOCs constitute a major fraction of VOC emissions from biomass burning and produce strongly light-absorbing brown carbon aerosol particles (BrC). Oxygenated aromatics contribute approximately 60% of total secondary organic aerosol (SOA) from biomass burning emissions, yet early-generation gas-phase products of their OH oxidation mechanisms remain poorly characterized despite evidence of significant OH-initiated oxidation in less optically dense smoke plume margins. Here, we present flow tube reactor experiments (~5 s residence time) coupled to an iodide time-of-flight chemical ionization mass spectrometer (I-CIMS) to detect and identify mechanistically important first-generation intermediates and products, including peroxy radicals and closed-shell functionalization, fragmentation, and dimerization products, from the OH oxidation of phenol, catechol, and guaiacol. OH radicals were generated via dark tetramethylethylene (TME) ozonolysis, with ozone concentrations stepped from 200 to 1000 ppb; corresponding OH concentrations were estimated via kinetic box model. Formula assignments enabled categorization of functionalization, fragmentation, and dimerization product families across the phenolic systems. Bicyclic peroxy radicals (BPR), among other peroxy products, were detected for phenol and guaiacol with a linear relationship to OH exposure, dimerization products exhibited scaling closer to second order, and fragmentation signals' OH dependence varied widely across the three systems. Ongoing work focuses on quantitative I-CIMS calibration using authentic standards for phenolic reactants and abundant fragmentation products alongside voltage-scanning declustering experiments to constrain iodide adduct binding energies and derive compound-specific sensitivities. Together, these efforts aim to improve understanding of phenolic VOC oxidation chemistry in photochemically active zones such as wildfire smoke plume margins.

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6ES.1

Producing "Gold Standard" Particles with the Silver Particle Generator. MAXIMILIAN DOLLNER, Paulus Bauer, Vinicius Berger, Kelvin Risby, Hans-Joachim Schulz, Jacob Swanson, Adam Boies, *Catalytic Instruments GmbH & Co.KG*

Spherical silver particles are on track to become the “gold standard” for the calibration of Condensation Particle Counters (CPCs) and other particle measurement instruments due to their advantageous properties: they are solid, inert, insoluble, and thermally stable. However, one of the major challenges is the generation of spherical silver particles larger than 100 nm at sufficiently high concentrations while avoiding secondary coagulation after the sintering process, which would compromise particle sphericity and size uniformity.

Existing generation methods, such as those based on conventional tube furnace systems, are often time-consuming, cumbersome to operate, and lack the flexibility required for efficient laboratory use. Here, we present a robust, flexible, and convenient approach for producing thermally stable, compact spherical silver particles with diameters of up to 100 nm. The generated particles are ideally suited as test aerosols for a wide range of applications, including CPC calibration, Volatile Particle Remover (VPR) testing, and aerosol instrument characterization.

The system consists of the Silver Particle Generator (SPG) from Catalytic Instruments, which generates primary silver nanoparticles. Controlled coagulation within the SPG-integrated residence chamber and the externally connected PCRF Accessory Kit (P1000) forms large agglomerates while simultaneously removing residual small silver particles through diffusional losses. These large agglomerates subsequently enter the Particle Sintering Device (S8000), where they are transformed into compact, thermally stable, and highly spherical silver particles.

In this presentation, you will learn how precise control of the evaporation–condensation process, combined with controlled coagulation and sintering, enables the stable production of spherical silver particles with narrow and adjustable size distributions. A live demonstration of the SPG setup will illustrate the complete particle generation process, highlighting how key operating parameters can be tuned to achieve targeted particle sizes and concentrations for calibration and aerosol testing applications.

6ES.2

EMILIE: A New Paradigm for Chemical Speciation of Sub-Micrometer Particles. NIKLAS LUHMANN, *Invisible-Light Labs GmbH, Austria*

Ultrafine aerosol particles (UFPs <100 nm) play a critical yet poorly understood role in public health and atmospheric processes, largely due to the analytical challenges associated with their low mass and complex composition. Established techniques for aerosol quantification, such as aerosol mass spectrometry, only detect molecular fragments and cannot efficiently measure particles smaller than ~70 nm. In contrast, traditional FTIR lacks the sensitivity for routine analysis at ambient UFP concentrations, requiring sample collection over several days. We introduce nanoelectromechanical system-based Fourier-transform infrared (NEMS–FTIR) spectroscopy, implemented in EMILIE™ , as a fast solution for functional group analysis of aerosols, independent of particle size.

EMILIE™ integrates aerosol collection and analysis onto a single platform, circumventing the need for sample transfer and associated artifacts. The enhanced sensitivity of NEMS-FTIR over conventional transmission spectroscopy permits measurements with sampling durations on the order of tens of minutes compared to hours or even several days. Recent studies have fully characterized NEMS-FTIR spectroscopy for environmental aerosols, benchmarking it against conventional filter-based methods at urban and rural sites. This enabled time-resolved insights into changes in oxidative potential at urban locations and chemical speciation of Arctic aerosols in different heights within a few hours [1]. A complementary study established the performance of EMILIE™ for analyzing nanoplastics, including polystyrene (PS), polypropylene (PP), and polyvinyl chloride (PVC), with detection limits as low as hundreds of picograms [2].

This presentation will highlight both the underlying technology and its practical deployment for urban and rural aerosol studies. In this showcase, we will introduce the technology behind NEMS-FTIR spectroscopy, discuss recent results from various field campaigns, and demonstrate the complete workflow: from aerosol collection to spectral acquisition and analysis.

[1] Surdu, M. et al. (2026), “Quantification of atmospheric aerosol chemical composition by nanoelectromechanical Fourier transform infrared spectroscopy (NEMS-FTIR)”, Sci. Adv. 12, eaeb2254.
[2] Timarac–Popović et al. (2026), “Picogram-Level Nanoplastic Analysis with Nanoelectromechanical System Fourier Transform Infrared Spectroscopy: NEMS–FTIR”, ACS Nano 20 (14), 11193-11208.

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6ES.3

Rayleigh Breakup and Ultra-Sonic Mesh Atomizing Spray Devices: Investigations Into Their Toxicology and Aerobiology Applications. Rudolph Jaeger, AMIT GUPTA, *CH Technologies (USA) Inc.*

New aerosol generation and delivery devices for respiratory aerosol exposure of test subjects, whether human, animal, or in-vitro cell or organoid culture, present substantial challenges. Notably, species-specific requirements for therapeutic and investigational respiratory dosing lead to technologies that deliver selected-size aerosols in the liters-per-minute range. Particle sizes ranging from sub-micron to greater than 10 microns are sought. Practical and affordable devices are the goals. From the polydisperse Collison pneumatic nebulizer to the spinning top monodisperse aerosol generator, a family of non-pneumatic devices has emerged. Notable is the vibrating mesh generator employing high-frequency oscillations to create highly concentrated aerosols.

Equally new to this field is Rayleigh breakup technology found in a one-fluid nozzle that uses elevated pressure to force liquids through a series of micron-sized openings. Crafted using computer chip technologies, these silicon wafers with defined pores are generated by stereolithographic methods. From this, a variety of devices for aerosol spray applications have been created. CH Technologies has adapted some of these products for use in aerobiology and inhalation toxicology applications. Notably, aerosol transport, drying, and charge neutralization, as well as dilution of freshly generated aerosols in a cost-effective and affordable research environment, will be presented.

Experiments were undertaken with various micron-pore-size grids and 5- and 12-micron mesh to generate near-monodisperse aerosols in the 2- 4- and 8–12-micron (by mass) size range. Research data will be shown with pores in the 1.75- and 1.9-micron sizes to yield aerosols in the less than 5-micron (by mass) size range.

6IA.1

Significant Cross-Contamination of Cooking Emissions in Multi-Story Buildings via Single-Unit and Building-Wide Assessment. Xiaoqiao Jiao, Wangchao Zhao, Wenting Yuan, Chao Pan, Shu Tao, CHEN WANG, *Southern University of Science and Technology*

Cross-contamination of cooking-related pollutants in multi-unit residential buildings is a common yet inadequately characterized issue. To investigate inter-apartment transport, we conducted an integrated assessment combining single-unit monitoring and building-wide measurements. First, a two-month intensive campaign was performed in a single apartment within a high-rise building, measuring particulate matter (PM), black carbon (BC), nitrogen oxides (NOx), carbon monoxide (CO), and volatile organic compounds (VOCs). Second, to assess the building-scale prevalence and vertical profile of transport, $PM_{2.5}$ concentrations were measured across all units of a separate multi-story residential building.

The detailed single-unit monitoring identified approximately two transmission events per day, leading to significant elevation of PM, BC, NOx, CO, and VOCs in both the kitchen and living room. These events were marked by a shift in particle geometric mean diameter from 76 nm (background) to 62 nm, resulting in a 40–80% increase in respiratory deposition of PM, particularly for fine particles in the alveolar region. Furthermore, 30 cooking-related VOCs, including hazardous aldehydes, were identified as transport indicators. The building-wide $PM_{2.5}$ measurements confirmed the prevalence of these cross-contamination events and enabled characterization of transport pathways and intensity across different floors. The integration of data from both measurement approaches validated key parameters related to source, characteristics, and vertical distribution of the pollutants.

The study demonstrates that leakage from shared kitchen exhaust ducts is a primary pathway for cross-contamination. Mitigation measures such as using exhaust hoods, operating air cleaners, or increasing natural ventilation during cooking were found to be effective. This work provides the first quantitative assessment of inter-apartment cooking emission transport in high-rise buildings, highlighting its significant impact on indoor air quality and exposure in high-density residential environments.

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6IA.2

PM2.5 from Cooking with Gas and Electric-Induction Stoves in California Homes. Yi Fang, Haoran Zhao, Anabelle Garza, Arlette Garcia-Ramirez, Briseida Vasquez, Debra Garcia, Jesus Rivera, Tim Tyner, Stephanie Holm, John Balmes, BRETT SINGER, *University of California, Los Angeles*

The Cooking Energy and Ventilation Impacts on Children's Asthma (CEVICA) study aimed to quantify the indoor air quality impacts of changing from gas to electric induction cooking in California's San Joaquin Valley. Particle concentrations were measured during 2-week intensive periods before and approximately three months after intervention, which was randomized in two stages. Gravimetric $PM_{2.5}$ was determined from filters and real-time $PM_{2.5}$ was measured by two different IAQ monitors with optical sensors. Indoor-emitted $PM_{2.5}$ events were identified from rapid increases from local baseline concentrations. Cooking was identified by analysis of temperature measurements above the stovetop. On average, across the first 39 homes that completed the study, detectable $PM_{2.5}$ increases were observed during about one-third of all cooking events. Increases in PM concentrations were often substantially delayed relative to the start of cooking. The fraction of $PM_{2.5}$ events associated with cooking, as well as the fraction of cooking events that had coincident detectable $PM_{2.5}$ increases, were each comparable between periods with gas and induction cooking. No statistically robust or consistent differences in $PM_{2.5}$ event peak concentrations or integrated prominence measured by the optical sensors were observed between gas and induction cooking periods. Gravimetric $PM_{2.5}$ tended to be higher during gas cooking phases than induction cooking phases, although only one comparison reached statistical significance. Integrated $PM_{2.5}$ concentrations from optical sensors were consistently lower than gravimetric $PM_{2.5}$. The magnitude of underestimation was larger during gas cooking phases, 28% and 40% on average for the two IAQ monitors. These results suggest potentially different responses of the sensors to cooking with gas vs. electric induction. This also may explain the analysis results that cooking-related $PM_{2.5}$ events measured by optical sensors were larger (though not with statistical robustness) for electric vs. gas cooking.

6IA.3

Potential Bias in Optical PM Sensor Response to Emissions from Cooking with Different Fuels. BRETT SINGER, Haoran Zhao, William Delp, Yi Fang, *Lawrence Berkeley National Laboratory*

There is interest in the potential to reduce cooking-related pollutant emissions by fuel choice, with particular attention to replacing gas with electric induction cooktops. While indoor air quality monitors with low-cost optical particle sensors seem a good tool to evaluate this intervention in occupied homes, they may introduce bias because the aerosols produced from each fuel have different characteristics. Specifically, the ultrafine particles produced by gas burners can serve as condensation sites for organics produced during cooking, resulting in a different mass distribution by particle size for gas vs. electric cooking. A change in the proportion of total mass that is below the particle size detection threshold of the optical sensor impacts the fraction of PM mass that is visible to the sensor and can thus change the effective response factor for the low-cost sensor relative to a measurement that is not as limited in the sizes of particles detected. This presentation will explore this potential bias through an exploration of data from experiments conducted by our group in both controlled laboratory and occupied residential settings, using a variety of low-cost sensors and reference PM monitors.

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6IA.4

High Ultrafine Particle Emissions and Inhalation Exposures from Dry Shampoo Products. JORDAN CROSS, Jianghui Liu, Nusrat Jung, *Purdue University*

Hair care products represent significant yet undercharacterized sources of ultrafine particle (UFP) and volatile organic compound (VOC) emissions in residential indoor environments. Dry shampoo products, widely used as time-saving alternatives to conventional washing, remain an underrecognized source of particle exposure with limited quantitative characterization. This study quantified real-time particle number size distributions and total volatile organic compound (TVOC) concentrations from commercial dry shampoo products under realistic indoor use conditions to assess breathing zone inhalation exposure potential. Fourteen controlled emission experiments were conducted using five commercially available dry shampoo products in a full-scale residential test house. Particle number size distributions (6 nm – 10 µm) were measured using a high-resolution electrical low-pressure impactor (HR-ELPI+) positioned in the user's breathing zone. TVOC concentrations were simultaneously monitored using photoionization detection (PID). Dry shampoo application generated peak particle number concentrations of $10^3 – 10^4$ cm^{-3}, with more than 90% of emitted particles exhibiting aerodynamic diameters (D_a) ≤ 100 nm and more than half smaller than D_a = 20 nm, indicating high respiratory deposition efficiency. Peak TVOC concentrations ranged from 2,500 – 4,000 ppb during application events. Number size distributions showed predominant contributions from nucleation and Aitken modes, with siloxane-containing formulations producing higher particle concentrations than non-siloxane alternatives. These findings identify dry shampoo use as a previously unrecognized indoor UFP source with significant inhalation exposure potential, highlighting the need for improved exposure assessment protocols and consideration of formulation impacts on indoor air quality and human health.

6IA.5

Participant-Centered Air Quality Communication for Residential Electrification Programs: Lessons from a Gas-to-Induction Stove Pilot. KATIE KEARNS, Dan Bertoldi, Helen Mejia, Jin Zhu, Michael Johnson, Sydney Jones, Mafe Aragon, Dana Charron, Madelin Hetrich, Laura Forni, Romina Diaz Gomez, Nicholas Lam, Tim Tyner, Peter Moschovis, Jessica Tryner, Rachit Sharma, Ajay Pillarisetti, *Berkeley Air Monitoring Group*

Background: Induction stove programs can reduce indoor air pollution, but households and communities need results communicated in ways that are understandable, locally relevant, and connected to daily activities such as cooking. Conventional summaries such as means and medians may obscure short pollution peaks and make stove-swap impacts difficult to interpret.

Objectives: We used Ava Community Energy's Health-E Communities gas-to-induction pilot in California's East Bay as a learning platform to develop participant report-back approaches for community-based residential electrification studies.

Methods: Kitchen air quality was monitored for approximately one week before and after induction stove installation in low-income households. Of 162 enrolled homes, 135 had valid paired data for key analyses. Lower-cost monitors measured PM2.5 and NO2, along with other indoor air quality indicators. Household-specific reports translated measurements into plain-language summaries, emphasizing minutes per day above selected Air Quality Index thresholds for PM2.5 (35.5 µg/m3) and NO2 (101 ppb), rather than relying only on average concentrations.

Results: NO2 showed a clear and consistent improvement after electrification, with 132 of 135 homes experiencing fewer minutes per day above the 101 ppb threshold after the stove swap. This metric made the removal of a combustion source visible in a way that could be communicated to participants. In contrast, PM2.5 patterns were more variable and did not show a consistent reduction after electrification. The PM2.5 findings highlight the importance of explaining that particle peaks can reflect cooking style, ventilation, outdoor infiltration, and other indoor sources, not stove technology alone.

Conclusions: The Ava pilot provided a practical foundation for participant-centered air quality communication. We are now applying these lessons in a larger evaluation of California's Equitable Building Decarbonization Program, using report-backs based on Home Health Box data from Access Sensor Technologies, a platform designed to generate household-level, time-resolved air quality information.

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6IA.6

Oxidative Potential of Particulate Matter Emitted During Controlled Cooking Activities. SAMAN HARATIAN, P. S. Ganesh Subramanian, Vishal Verma, Mohammad Heidarinejad, Brent Stephens, *Illinois Institute of Technology*

Prolonged exposure to particulate matter (PM) is associated with morbidity and mortality, and indoor PM sources often dominate total PM exposure. Oxidative potential (OP) of PM quantifies the ability of PM to induce oxidative stress, and has emerged as a useful surrogate metric for PM toxicity. Cooking is a predominant source of PM2.5 in non-smoking households, yet the OP of cooking-generated PM has not been systematically investigated. Therefore, this work seeks to experimentally characterize the OP of PM emitted from cooking activities.

Controlled laboratory experiments were conducted in a fume hood to investigate particulate matter (PM) emissions from pan-frying frozen beef patties using four cooking oils: olive, canola, avocado, and peanut oil. An electric heat source was maintained at a constant temperature, resulting in cooking oil temperatures below the smoke point of each oil (~205°C). Real-time particle concentrations were measured using a scanning mobility particle sizer (SMPS) and an optical particle sizer (OPS). Inertial impactors were used to collect PM2.5 on filters for chemical analysis and oxidative potential (OP) assessment using the dithiothreitol depletion assay. Time-integrated gravimetric measurements were used to estimate PM2.5 mass emission rates based on duct cross-sectional area and airflow velocity. Preliminary results showed mean (SD) PM2.5 emission rates of ~2×10e5 (SD=1.4×10e4) μg/hr across all experiments, consistent with values reported in the literature, with minimal variation among oil types at these temperatures. Intrinsic OP (mass-normalized OP) ranged from 15–23 pmol/(min·μg), exceeding values reported for most non-combustion indoor sources and comparable to some combustion sources, such as certain incense emissions. Future work will examine the effects of cooking temperature and food type on PM oxidative potential.

6IA.7

Particle Emissions from Electric Cooking: Characterizing UFP and PM2.5 from Induction Stoves and Air Fryers. Joshua Harper, Lily Mueller, Robert T. Nishida, TIANYUAN LI, *University of Waterloo*

Cooking is a major contributor to indoor air pollutants. Compared with natural gas stoves, electric stoves generally produce fewer gas-phase pollutants, and induction stoves have gained popularity as a cleaner, more efficient option. Air fryers have also become more popular because of their convenience and consumers' interest in low-oil cooking. Although emerging studies have examined emissions from these appliances, their findings remain inconsistent, making it essential to characterize their emissions under controlled conditions for comparable tasks. In this study, we cooked equal portions (100 g) of asparagus, frozen fries, and chicken breast each using a basket-style air fryer and an induction stove with a stainless steel pan, both previously used, in a 0.63 m^3 positively pressurized chamber to prevent infiltration of room air pollutants. All food items were cooked with 4 g of canola oil using both appliances, and without oil in the air fryer. In addition, both appliances were operated without food. All activities were repeated three times. Particle number and mass concentration measurements were made by a GRIMM SMPS+E and a MiniWRAS 1371, with emission rates determined using a mass balance modelling approach. For the same cooking activity, the air fryer generated higher number concentrations with a smaller size distribution (dominated by UFPs). Peak UFP concentrations did not follow a consistent order among food types for either appliance. UFP emission rates from the air fryer ($0.7 – 1.1\times10^{13}$ #/min) were slightly higher than those from the induction stove ($0.5 – 0.8 \times10^{13}$ #/min). Cooking without oil did not elevate the PM2.5 concentrations from baseline; however, the addition of oil in the air fryer substantially increased peak PM2.5 concentrations (up to 9,600 $\mu g/m^3$) and emission rates, particularly for chicken breast. Operating the appliances without food also generated a substantial amount of UFP, especially during the initial test run of the previously used air fryer (1.1×10^{13} #/min). Overall, these results show that both induction stove and air-fryer use can substantially elevate indoor particle concentrations. However, because the emissions are dominated by particles smaller than 0.3 μm, their presence may remain poorly detected by consumer-grade optical sensors. Future research should investigate how air fryer type, cooking duration, and food type influence emissions to better understand their implications for indoor air quality.

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6IA.8

The Impact of Behavioral and Environmental Factors on Surface Dust Mass Loadings and Particle Size Distributions in Residential Dwellings. BRIAN MAGNUSON, Minh-An Luu, Satya Patra, Brandon E. Boor, *Purdue University*

Infants experience elevated indoor dust exposure during key motor development stages, with crawling behaviors inducing resuspension and surface contact transfer of particles from accumulated dust surface loadings. House dust poses significant risks for inhalation and ingestion of toxicants in infants, including heavy metals, flame retardants, per- and polyfluoroalkyl substances, plasticizers, microplastics, and antimicrobials. Allergens and microorganisms in house dust pose respiratory health risks but have also been linked to protective effects against childhood asthma and allergy development. To quantify infant-specific dust exposure, this study addresses the impact of behavioral and environmental factors on surface dust mass loadings and particle size distributions in infant-occupied residential dwellings in New York, NY, and West Lafayette, IN, classified as urban and rural/suburban environments, respectively. Indoor dust samples were mechanically sieved to ≤ 2800 µm to remove larger fibers, food fragments, and debris, isolating super-millimeter fractions from finer dust fractions relevant to ingestion and inhalation pathways. Size-resolved classification of 432 collected samples revealed that rural/suburban dwellings had significantly higher sieved surface dust mass loadings (average: 3.76 g m^{-2}) compared to urban dwellings (average: 2.07 g m^{-2}). City-classified mass loading datasets were compared through statistical analysis of behavioral factors (indoor shoe policies, window-opening habits) and environmental factors (flooring types, pet ownership). Particle size distribution analysis identified volume-based median peaks at 25.8–48.7 µm, with effects of behavioral and environmental factors on size distributions further analyzed. Morphological analysis via single-particle imaging characterized the physical composition of indoor dust loadings. This comprehensive analysis identifies dominant behavioral and environmental factors influencing infant dust exposure pathways.

6IM.1

A Bipolar Chemical Ionization Mass Spectrometry for Online Detection of Atmospheric Organic Molecules. JINGKUN JIANG, Zitao Yan, Zhaojin An, Dandan Li, Yuyang Li, *Tsinghua University, China*

Chemical Ionization Mass Spectrometry (CIMS) is a pivotal technology for online analysis of atmospheric trace gases. However, the limited sensitivity of a single chemical ionization (CI) scheme constrains its application in complex atmospheric matrices. In this study, we developed a novel bipolar CI source by integrating a mixed reagent gas (diethylamine and nitric acid) and a voltage switching module into a typical flow tube inlet. Coupled with an Orbitrap mass spectrometer (bipolar CI-Orbitrap), this source enables rapid (~10 s) switching between reagent ions of $C_4H_{12}N^+$ and NO_3^- with stable signals under atmospheric pressure. After optimization, the limits of detection using $C_4H_{12}N^+$ and NO_3^- were 1.1 and 2.9 ppqv, respectively, comparable to those of commercial atmospheric-pressure CI sources. During a six-day campaign in urban Beijing, the reagent ions maintained high signal intensities of 10^6 cps with excellent stability, ensuring efficient and reliable ionization. The bipolar CI-Orbitrap identified 1405 and 1696 atmospheric organic molecules via $C_4H_{12}N^+$ and NO_3^-, respectively, covering species with 0–18 oxygen atoms. Notably, the temporal evolution of a wide range of typical monoterpene oxidation products were detected, ranging from $C_{10}H_{16}O$ to $C_{10}H_{16}O_{10}$. The bipolar CI-Orbitrap compensates for the deficiency of single NO_3^--CIMS in detecting low-oxidation-state organic species, thereby providing a more comprehensive insight into atmospheric chemistry.

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6IM.2

Demonstration of a Novel Ultrafine Particle Monitor Based on Pulsed Bipolar Charging. JOSHUA HARPER, Tyler J. Johnson, Colin Dwyer, Conor Ruzycki, Robert T. Nishida, *University of Waterloo*

There remains a critical gap in widely-deployable technologies for measuring ultrafine particles (UFPs), despite their prevalence and established links to adverse health effects. Recent advances in charge-based UFP monitors are filling that gap, however, existing devices face limitations including signal variability and maintenance associated with corona discharge onset and fouling and sensitivity to pre-existing charge on sampled particles in field deployment.

To address these challenges, this work demonstrates a compact bipolar charging monitor for UFPs in which particle charging is periodically modulated between net positive and negative polarities, and the induced current is measured. While sensing based on pulsed unipolar charging (on/off) is widely utilized, to the authors' knowledge, this is the first sensing method to utilize pulsed bipolar charging. For a wide range of particle concentrations (to $>1\times10^5$ # cm^{-3}) and particle sizes classified by a Differential Mobility Analyzer (20 – 75 nm) or Aerodynamic Aerosol Classifier (100 – 500 nm), the device response shows clear linearity with the first moment of the particle size distribution, as predicted by theory. This metric is directly converted to an alveolar lung-deposited surface area (LDSA). A numerical model is developed that links particle charging and transport to the electrometer response, including a residence time distribution (RTD) to account for flow effects within the sensing volume. Strong agreement between the experimental results and the model across a range of flow rates (0.25 to 1.0 L min^{-1}) and pulsing frequencies (0.3 to 4.75 Hz) validates the physical understanding of the pulsed bipolar method. By applying both charge polarities within the novel pulsed bipolar charger, the method provides more stable signals and reduced sensitivity to pre-existing particle charge compared to unipolar approaches, enabling robust long-term ambient measurements. These results establish pulsed bipolar charging as a viable and advantageous approach for hyper-local UFP monitoring.

6IM.3

Droplet Microfluidics-Based Capture and Transfer of Single Aerosol Particle-Droplets for On-Chip Single-Particle Analysis. WENDY FLORES-BRITO, Ryan Sullivan, *Carnegie Mellon University*

Physicochemical analysis of individual aerosol particles continues to be a challenge since few techniques exist that can preserve an aerosol's individual identity while transferring and preserving each particle for subsequent chemical analysis. Here, we present a new approach combining droplet microfluidics-based aerosol droplet capture method with surface enhanced Raman spectroscopy (SERS) for online chemical analysis. The droplet capture method features direct activation of individual aerosol particles into droplets by water vapor condensation followed by droplet capture into an open channel microfluidic device while potentially maintaining their individual particle–droplet pair identity in an immiscible fluid. We compared the TSI CCN Counter with the Sequential Spot Sampler for our droplet activation columns and collected the single-particle-droplets into the oil-filled open channel of the microfluidic device. We present initial SERS results from the captured droplets that are then transferred in real time to a secondary microfluidic device designed for particle chemical analysis such as through incorporating SERS nanoparticles with the captured and transferred particle-droplet pairs for enhanced Raman microscopy analysis. The combination of particle activation, direct capture into oil in a microfluidic chip, and subsequent on-chip chemical analysis affords a promising integrated platform for the sampling and chemical analysis of single aerosol particles using small microfluidic devices.

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6IM.4

A Condensation Diffusion Charger for Particle Number Measurement from 3 nm up to 10^7 cm^{-3}. ALEXANDER BERGMANN, Helmut Krasa, Victoria Fruhmann, *Graz University of Technology*

Particle number (PN) concentration is the established metric for ultrafine aerosols, whose health impact is increasingly reflected in regulatory frameworks. Existing PN instruments cover this measurement task only partially: condensation particle counters (CPCs) reach down to a few nanometres but saturate above roughly 10^5 cm^{-3} in single-count mode, while electrical instruments based on diffusion charging (DC) handle high concentrations but suffer from an inherent size dependence and a cutoff diameter typically well above 10 nm. Capturing the full size and concentration range of real-world emissions, therefore, requires either upstream dilution or multiple instruments operated in parallel.

In this work, we present the Condensation Diffusion Charger (CDC), which combines a laminar-flow diethylene-glycol growth stage with a corona-based DC and a Faraday cup electrometer. Polydisperse seed particles are grown into monodisperse ∼2 µm droplets before charging, removing the size dependence of the electrical signal. Finite-element simulations of the growth stage were used to dimension the saturator and condenser and to model activation and droplet growth.

Experimentally, the CDC achieves a counting efficiency of 50 % at 3 nm mobility diameter, a size-independent response above 10 nm, and resolves concentrations from below 50 cm^{-3} up to 1.5×10^6 cm^{-3} at a flow rate of 0.54 L $mincm^{-1}$ — a dynamic range that exceeds the single-count regime of CPCs by roughly an order of magnitude. Validation against a 2.5 nm reference CPC on a category-L chassis dynamometer shows close peak-to-peak tracking ($R^2 = 0.90$). In addition, we present a refined sensor concept that pushes the upper concentration limit to 10^7 cm^{-3}, extending the CDC's accessible range to more than five orders of magnitude and underlining its potential for compact, dilution-free PN monitoring of real-world ultrafine emissions.

6IM.5

Multi-Instrument Isokinetic Aerosol Sampling Across a Continuous Velocity Range. Benjamin Kokaly, Meghan Megowan, XIAOSU DING, Caleb Rismiller, Parichehr Salimifard, *Oregon State University*

Current isokinetic sampling systems utilize an assisting pump that supplements the instrument airflow, increasing the sample flow rate, creating isokinetic conditions at an interchangeable inlet. However, the instrumentation and assisting pump have a fixed flow rate, limiting capabilities to match only one stream velocity per inlet diameter. This limits testing capabilities to discrete stream velocities and requires purchasing new inlets for each stream velocity. However, changing an inlet requires halting testing, and isokinetic systems may support only a single instrument.

In order to address this limitation, we developed the Multi-Instrument Isokinetic Sampling System (MIISS) with the primary objective of expanding the isokinetic velocity range for each inlet. We achieve this by utilizing an assisting pump with an adjustable flow rate, which allows us to alter the inlet airflow velocity by increasing or decreasing the sampling flow rate. After entering the system, particles are split across 1-3 sampling instruments, with excess flow exiting through the assisting pump. To minimize transport losses, flow inside the system at operating flowrates is laminar. Tri-clover fittings maintain constant inner diameter across sections, while insulated duct connections reduce the effects of vibration. To prevent bias when splitting particles, flow splitters are ≤7° from vertical and are rotationally symmetrical. In addition to these considerations, all system materials that come into contact with particles have a smooth finish and are grounded to prevent charge buildup.

To verify the accuracy of MIISS, collected data is compared to that of a reference instrument using an independently manufactured isokinetic sampling system while the duct is running at the reference stream velocity. As MIISS hosts multiple sensors, each sensor's performance is compared across configurations to evaluate potential bias.

Overall, this expanded isokinetic sampling range for each inlet results in stream velocity being less of a constraining factor, broadening our testing capabilities.

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6IM.6

Establishing Coarse PM Calibration Practices Using Low-Cost Optical Particle Counters. MIKYLA HARJAMAKI, Michael Hannigan, *University of Colorado Boulder*

While low-cost sensor calibration methodologies are well-established for many gas-phase pollutants and fine particulate matter, they remain relatively unexplored for coarse particulate matter (PMc). Without established best practices, PMc field measurements from low-cost sensors may fail to capture dust events or concentration enhancements from other local sources. Furthermore, existing studies on PMc calibration and field performance rarely include the Alphasense OPC-R2.

To address these gaps, we colocated OPC-R2 sensors with reference-grade instruments at both urban and rural sites, capturing variation in particle properties and size distributions across source environments. Using this data, we systematically optimized regression models by evaluating a range of models and input variables, including bin counts, concentration estimates, temperature, and relative humidity. Model performance was further improved through target variable transformations, sample weighting, and hyperparameter tuning. Additionally, we assessed model performance when using three common colocation schemes, universal, individual, and 1-hop (two-step), to identify the trade-offs between calibration performance and the logistical feasibility of colocating each sensor within a network for an extended period.

The optimized calibration models were then applied to new field measurements taken at reference stations, enabling direct validation against reference values. With colocation and deployment sites spanning both urban and rural environments, we tested how calibration performance changes across scenarios where the two environments were the same, similar, or distinct.

Our results offer key insights into effective PMc calibration practices using low-cost optical particle counters, which are essential for obtaining accurate concentrations from sensor networks. These findings are being applied to an ongoing OPC-R2 network deployment across Salt Lake City, aiming to distinguish roadway and non-roadway contributions to coarse PM.

6IM.7

Evaluation of the Met One Instruments OPX 1025 Optical Particulate Matter Mass Monitor. STEPHEN TONER, Dylan Deems, *Met One Instruments, Inc.*

Precise characterization of ambient particulate matter (PM) is critical for air quality management and regulatory compliance. This manuscript details the operational methodology and field evaluation of the OPX 1025, a novel optical particulate matter (PM) mass monitor engineered by Met One Instruments Inc. The OPX 1025 utilizes an advanced optical particle spectrometer and the proprietary climate-corrected dynamic mass algorithm (known as RealPM) to deliver high-frequency, real-time measurements of PM1, PM2.5, PM4, PM10, and PM10-2.5, as well as particle counts and size distributions. Field trials conducted at four diverse U.S. EPA sites assessed the instrument's performance under a range of challenging environmental conditions, including high PM concentrations, variable humidity, temperature fluctuations, and wildfire smoke events. Results demonstrated strong correlation with regulatory reference samplers, confirming the OPX 1025's accuracy, even in challenging sampling conditions. These findings highlight the OPX 1025 as a promising solution for regulatory and research applications in ambient air quality monitoring.

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6IM.8

Extracting Maximum Information from Single Particle Soot Photometers (SP2). DARREL BAUMGARDNER, *Droplet Measurement Technologies, Boulder, Colorado*

The Droplet Measurement Technologies (DMT) Single Particle Soot Photometers (SP2-D, SP2-Blue, SP2-XR) measure the magnitude of light produced by incandescing refractory black carbon (rBC), mixed with particles, that pass through a highly focused laser beam. Although the exact composition of the material mixed with the rBC can't be determined from the measurements provided by the SP2, the analog signals from the light scattering and incandescence detectors contain information that can be used indirectly to deduce the relative volatility of the material is that is mixed with the rBC.

Materials that are mixed with the rBC will usually begin to vaporize as the rBC heats during incandescence. Sometimes this material will be completely vaporized, depending on its composition and volatility; however, there are some materials that will not completely transition to gas. An analysis of the time when the incandescence signal begins to increase compared to the scattering signal peak time provides a metric that will determine if the material mixed with the rBC will potentially evaporate and comparing the Half Width Half Maximum (HWHM) of the scattering signal to its transit time provides additional information about the rate of evaporation. Data sets from three locations were analyzed for this study: 1) Southern California in the autumn of 2021, 2) Northern Atlantic in 2022 and 3) Northern Greenland in the summer of 2024. Comparison of the signal shape metrics shows distinctive differences that are results of rBC mixed with different materials connected to local and distant sources. This presentation will demonstrate that there can be additional information extracted from the SP2XR measurements that allow more details about mixing state and particle volatility, connected to particle age.

6RM.1

Atmospheric Ammonia and Amines Observed in Fall 2025 During a Coastal Campaign at Boothbay, Maine. Christine Troller, Joy Kiguru, Gabriella Iacono, Steve Archer, COTY JEN, *Carnegie Mellon University*

Reduced nitrogen species such as ammonia (NH_3) and low-molecular-weight amines influence atmospheric aerosol formation, particle growth, and air quality, yet observations in coastal marine environments remain limited. Here we report high-time-resolution measurements of ammonia, C1–C4 amines, pyrroline, and pyridine obtained during a 5-week coastal field campaign in the Gulf of Maine in September 2025 using hydronium chemical ionization mass spectrometry (CIMS). Ammonia was the dominant reduced nitrogen species, with mean concentrations of 626 pptv, while amines were present at low pptv levels. All compounds exhibited clear diel variability with elevated daytime concentrations and weak positive correlations with temperature, suggesting contributions from temperature-dependent volatilization, biological activity, or gas–particle partitioning. Regional wind analysis indicated that amine concentrations were systematically higher during land-sector flow, whereas ammonia showed little dependence on wind sector, consistent with the shorter atmospheric lifetimes of amines and higher sensitivity to nearby sources. Correlation analysis further revealed weak relationships between ammonia and individual amines but strong correlations among several amines, suggesting shared emission influences or common atmospheric processing. Episodic enhancement events were observed in which multiple amines increased simultaneously within short time windows, indicating plume transport from localized sources. Overall, ammonia concentrations at this coastal site were elevated relative to remote marine environments but lower than strongly urban or agricultural regions, while amine levels were comparable to remote marine background and some urban conditions. These results highlight the complex interplay of marine emissions, terrestrial influences, and atmospheric transport in controlling reduced nitrogen in coastal environments and provide an observational baseline for evaluating future changes in marine–atmosphere nitrogen exchange in a rapidly warming region.

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6RM.2

Acid-Base Nucleation and Tide-Driven Biogenic Precursors at a Gulf of Maine Coastal Site. JOY KIGURU, Christine Troller, Ziheng Zeng, Malena Rybacki, Dallan Schoenberger, Gabriella Iacono, Steve Archer, Coty Jen, *Carnegie Mellon University*

Coastal environments represent a distinct regime for atmospheric new particle formation (NPF) behavior due to the mixed influence of open-water emissions, tide fluctuations, and land-based anthropogenic contributions. While NPF has been observed across urban, agricultural, and marine environments, coastal measurements pairing gas-phase precursors with nucleation mode particles remain limited. This gap is particularly consequential as coastal regions are facing some of the most rapid environmental changes due to climate change. The Gulf of Miane, USA has been identified as warming faster than 97% of the world's ocean surface. This study presents simultaneous measurements of gas-phase NPF precursors and sub-3nm particles collected during a 5-week campaign in Boothbay, ME in September 2025. Three mass spectrometers provided high-time-resolution gas-phase measurements, and the Condensation Particle Counters For Rapid Atmospheric Measurements (CPC FARM) captured particle measurements down to 1.6 nm in diameter. Instruments were deployed directly at the shoreline to sample air masses directly under tidal influence, supplemented by an anemometer and Tempest weather station for meteorological context. Both acidic and basic precursors were quantified including sulfuric, methanesulfonic, and iodic acids as well as ammonia and C1-C3 amines. The shore was lined with Ascophyllum nodosum macroalgae, an established iodine emitter, resulting in daily peaks of iodic acid during low tide which correlated strongly with the appearance of sub-3 nm particles. Consumption of bases was similarly found to correlate with particle bursts events. NOAA HYSPLIT back trajectory analysis revealed that the measured concentration of sulfuric and methanesulfonic acids were heavily influenced by transport from both urban and agricultural source regions. Together, these observations represent one of the first paired acid-base characterizations of NPF in a coastal environment, demonstrating that both acidic and basic precursors are needed to fully capture nucleation behavior at the land-sea interface.

6RM.3

Atmospheric Aerosol Formation and Characteristics in the Alaskan Boreal Forest: Observations from the DENALI Campaign. STEVEN JOB THOMAS, Cecilia Righi, Myriam Agrò, Wei Huang, Ayomide Akande, Zachary Payne, Aki Nissinen, Bingying Zhao, Iida Pullinen, Angela Buchholz, Arttu Ylisirniö, Timothy Onasch, Francesca Salteri, Yvette Nadine Gramlich, Yiwei Gong, James Campbell, Nina Sarnela, Olga Garmasch, Siegfried Schobesberger, Nadine Borduas-Dedekind, Claudia Mohr, Federico Bianchi, Jingqiu Mao, et al., *University of Helsinki*

Aerosols influence climate and human health by affecting radiative forcing, cloud formation, and air quality [1]. Boreal forests are major sources of biogenic volatile organic compounds (BVOCs), which act as key precursors for secondary organic aerosol formation [2]. While aerosol formation in European boreal forests has been studied extensively, observations from the North American boreal forest remain limited despite its distinct vegetation, climate, and emission characteristics.

To address this gap, atmospheric measurements have been conducted since 2023 at a boreal forest site near Delta Junction, Alaska (63°52'58"N, 145°45'02 W), co-located with the National Ecological Observatory Network (NEON) and integrated within the Atmospheric Science and Chemistry Measurement Network (ASCENT). During summer 2025, for the intensive DENALI campaign (Dynamics of Emissions Nucleation and Aerosols to predict Land–atmosphere–climate Interactions) we deployed a comprehensive suite of instruments to measure trace gases and the physical and chemical properties of aerosols in the Alaskan boreal forest.

Initial observations from the DENALI campaign indicate that about 40 % of the period was influenced by wildfire smoke transported from Alaska and Canada. During clean conditions, $PM_{2.5}$ concentrations were low, with mean organic aerosol levels less than 1 μg m^{-3}, whereas wildfire periods had an enhanced aerosol loading with organic aerosol mass reaching up to ~80 μg m^{-3}. Episodic sulfate increases were observed during some smoke events, with one episode possibly linked to a volcanic eruption in Russia in early August. Despite several periods with relatively low aerosol loading, new particle formation events were observed only rarely during the campaign, indicating differences from the frequent NPF observed in European boreal forests. Further analysis of the DENALI dataset will help clarify the processes controlling aerosol formation and evolution in the North American boreal forest.

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6RM.4

Seasonal Trends in Ultrafine Aerosol Composition and New Particle Formation in the Southern California Desert.

CONNOR SETO, Kristen Cramer, Megan Harmon, Jackson Ryan, Berenice Rojas, Sanjeevi Nagalingam, Alex Guenther, Celia Faiola, Madeline Cooke, James Smith, *University of California, Irvine*

Ultrafine aerosols (<100 nm) have been shown to have impacts on the Earth's climate system and weather. These particles and gases also affect human health by increasing the risk of respiratory and cardiovascular diseases. Limited studies exist of ultrafine aerosols in the southern California desert reporting interactions between biogenic volatile organic compounds (BVOCs) and transported anthropogenic aerosols. To better resolve seasonal trends in ultrafine composition and chemical interactions throughout the year, a multi-season, multi-site campaign was conducted with a suite of instruments capable of resolving aerosol size distribution and chemical composition at three different southern California desert sites. This study presents recent results from the Desert Plant Emissions and Aerosol Chemistry Experiment (Desert PEACE), which was conducted during periodic campaigns in 2026.

This study provides an overview of seasonal trends with meteorological conditions in the composition of ambient ultrafine aerosols. Observations suggest strong seasonal dependence on the magnitude and relative proportions of BVOC, with warmer temperatures corresponding to higher concentrations overall. These warmer temperatures are also associated with new particle formation and growth. These events are sometimes observed regionally at multiple sites tens of kilometers apart. Early observations exhibit consistent changes in aerosol composition during growth events, suggesting a unique chemical pathway for these events.

In addition, we used NOAA's HYSPLIT back trajectory model to infer potential sources and transport patterns of species known to influence nucleation and growth. Specifically, we used concentration weighted trajectories, an analysis method that uses modeled back trajectories to visualize the transport of relevant precursors to the sites. The results highlight the significance of urban emission sources west of the sites. The analysis also emphasizes the role of locally emitted biogenic precursors. This work provides insights into the chemical and meteorological conditions that drive ultrafine composition in an understudied desert region.

6RM.5

Chemical Composition of Coastal Ultrafine Aerosol Particles via Orbitrap High-Resolution Mass Spectrometry.

TERESA PALACIOS DIAZ, Anna Kapp, Kristen Cramer, Adam Thomas, James Smith, *University of California, Irvine*

Ultrafine (sub-100 nm) marine aerosol particles originate from primary emissions such as wave breaking and bubble bursting, as well as through secondary processes such as new particle formation. These primary and secondary particles can subsequently evolve through condensational growth and reactive uptake processes, similar to those observed in continental environments. The sources and mechanisms driving particle formation and early-stage growth in coastal marine atmospheres, however, remain poorly constrained. Here, we present a characterization of ultrafine aerosol particles collected near the coast of San Diego, California, during the Eastern Pacific Cloud Aerosol Precipitation Experiment (EPCAPE) in Spring 2023. Ultrafine particles were sampled onto filters using a micro-orifice uniform deposit impactor (MOUDI) as a pre-filter. These filters were extracted and analyzed offline using ultrahigh-performance liquid chromatography (UHPLC) coupled with Orbitrap high-resolution mass spectrometry (HRMS). Observed ultrafine particle composition was consistently dominated by methanesulfonic acid, sulfuric acid, isoprene-derived organosulfates, and amines, indicating a combination of marine biogenic and coastal anthropogenic influences. Particle composition remained relatively consistent throughout the campaign, with back trajectories showing transport from Los Angeles and Long Beach and predominantly northwesterly winds from the Pacific Ocean. The detection of 2-methyltetrol sulfate (2-MTS) specifically provides evidence for reactive uptake of isoprene epoxy diols (IEPOX) onto acidic ultrafine particles, indicating that IEPOX-driven chemistry contributes to particle growth at smaller sizes than typically considered. These findings demonstrate that coastal ultrafine particles are influenced by both marine and anthropogenic chemistry and may play a large role in cloud condensation nuclei (CCN) populations, with implications for coastal cloud formation and radiative effects.

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6RM.6

Vertical Distribution and Composition of Long-Range Transported Iodine Aerosol in the Free Troposphere. AMNA IJAZ, Jerome Fast, Fan Mei, Mikhail Pekour, Beat Schmid, Israel Silber, Kaitlyn Suski, Jason Tomlinson, Adam Varble, Alla Zelenyuk, *Pacific Northwest National Laboratory*

Iodine is an essential micronutrient and an important atmospheric oxidant, with iodine-driven catalytic ozone loss estimated to exceed that of chlorine and bromine combined. Although particulate iodine is typically only a trace constituent in the marine boundary layer and remote troposphere, we report the first observations of iodine-rich aerosol particles in the free troposphere over central Argentina during the 2018 Cloud, Aerosol, and Complex Terrain Interactions (CACTI) aerial campaign.

Single-particle measurements show these particles are composed of iodine mixed with nitrates, suggesting a terrestrial source from the northwestern deserts of the South American Arid Diagonal, including the Atacama Desert, which contains exceptionally iodine-rich nitrate (caliche) deposits. Dust-borne iodine from this region has previously been linked to regional decreases in tropospheric ozone (~8%), degradation of surface air quality through new particle formation, and sustained cycling between gas and particle phases that can influence iodine in ice and stratospheric aerosol.

Trace iodine signals were also detected in other particle types, indicating active multiphase processing involving iodine release and recondensation. These results identify northern Chilean desert dust and the iodine production region as a previously underappreciated pathway for transporting reactive iodine to the continental free troposphere, with implications for oxidation capacity, secondary aerosol formation, and ozone budgets.

More broadly, CACTI observations challenge the prevailing view that particulate iodine is only a minor aerosol component. Here, we find that aerosols retained iodine as a major constituent during >1000 km of transport from northern Chile to the central Argentine free troposphere. We infer that very low relative humidity and transport at elevations above ~3000 m limited rapid multiphase recycling and photochemical loss, allowing iodine-bearing particles to persist far from their sources and remain environmentally relevant.

6RM.7

Unexpected Aerosol Acidity in Remote Marine Aerosols: Low pH Observed in Submicron Particles over the Southern Ocean. KAYLEIGH REILLY, Tiantian Zhu, Cara Waters, Andreas Schmitt, Ruhi Humphries, Melita Keywood, Branka Miljevic, Clare Paton-Walsh, Dagmar Kubistin, Christina S. McCluskey, Kerri Pratt, Andrew P. Ault, *University of Michigan*

Aerosol acidity plays a crucial role in many key atmospheric processes including the formation of secondary aerosols, heterogeneous chemical reaction rates and mechanisms, gas-particle partitioning, and oxidation reactions. Despite its importance, there continues to be a gap in the ability to accurately measure or predict aerosol pH in the ambient atmosphere, mostly due to aerosol complexity and the non-conservative nature of the H^+ ion. Previous methods have been used to bridge this gap with highly simplified proxies, and while they have provided important insights, many still contain some limitations that bias their results. One common limitation is the inability to account for pH size-dependence. Chemical thermodynamic models including E-AIM and ISORROPIA that are used to predict pH especially struggle in remote/marine regions, typically overestimating acidity. Thus, field-deployable, size-resolved acidity measurement techniques are critically important for furthering our understanding of aerosol acidity in the ambient atmosphere, especially in remote regions. Herein, we deployed a pH paper colorimetric approach at a field site located near the Southern Ocean in Tasmania, Australia to directly measure size-resolved aerosol acidity. The Southern Ocean is of particular importance as there have not been direct measurements of aerosol pH over this region. Our results show that aerosol acidity is size-dependent and more acidic in the submicron size range even for baseline conditions. We also show that submicron sea spray particles acidify more rapidly compared to supermicron sized sea spray. Furthermore, our work highlights the importance and understanding of both aerosol acidity and surface area and number size-distributions to understand the pH of aerosols at the key sizes for heterogeneous reactions.

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6RM.8

Investigation of Wintertime Nitrate in Mammoth Cave National Park. AMY P. SULLIVAN, Jihee Ban, Taehyun Park, Andrey Marsavin, Bret Schichtel, Anthony J. Prenni, Jeffrey L. Collett, Jr., *Colorado State University*

Mammoth Cave National Park is a Class 1 protected area located in KY in the southeastern U.S. For at least the past decade, elevated wintertime nitrate concentrations of approximately 3 times higher than during the other seasons have been observed in the park. Nitrate formation and evaporation is a complex function of gas-phase ammonia and nitric acid concentrations, meteorological conditions, and existing particle composition that determine particle liquid water concentrations (LWC) and pH. It is important to identify the factors leading to and the main sources of nitrate in order to understand how to control its emissions in this region. Therefore, to further investigate this, we made ground-based measurements of nitric acid, ammonia, and the inorganic aerosol composition in Mammoth Cave National Park in Jan.-Feb. 2025. Twenty-four hour integrated URG denuder and filter pack measurements were conducted. In addition, near real-time measurements of aerosol composition and ammonia were provided by a PILS-IC (Particle-into-Liquid Sampler – Ion Chromatography) system and a Picarro G2508 Analyzer, respectively. Results from these measurements will be presented. A number of ammonium nitrate events were observed during the study with nitrate concentrations ranging from 0.5 to 6 $\mu g/m^3$ and typically representing 20% of the $PM_{2.5}$ mass. The first and second halves of the study exhibited different patterns with higher gas-phase concentrations being observed during the latter. Thermodynamic modelling was performed and showed strong agreement with both the time-integrated and near real-time measurements, confirming reliable model-measurement performance. How parameters such as temperature, transport, and precursor availability played a role in driving wintertime nitrate formation and variability in this region will be discussed.

6TA.1

Single-Particle Insights Into IEPOX-SOA Chemistry During Aerosol-Cloud Cycling: Field Observations, Cloud-Chamber Experiments, and Particle-Resolved Modeling. ALLA ZELENYUK, David Bell, Kaitlyn Suski, Georges Saliba, Amna Ijaz, Payton Beeler, Laura Fierce, John Shilling, Yuzhi Chen, ManishKumar Shrivastava, Joel Thornton, Raymond Shaw, Jerome Fast, Will Cantrell, Jesse Anderson, Richard Flagan, Gourihar Kulkarni, Jason Surratt, Avram Gold, Mikhail Ovchinnikov, Tania Guatam, Swarup China, Adam Varble, Mikhail Pekour, et al., *Pacific Northwest National Laboratory*

Isoprene epoxydiols (IEPOX) are key precursors to secondary organic aerosol (SOA), yet the influence of aerosol-cloud cycling on IEPOX-SOA formation and oxidation remains poorly constrained. We combine real-time single-particle field observations, laboratory and cloud-chamber measurements, and particle-resolved aerosol-cloud modeling to determine where IEPOX-SOA forms within the aerosol-cloud lifecycle (wet aerosol, cloud droplets, or evaporating droplets) and to explain differences between ambient and laboratory IEPOX-SOA mass spectral signatures.

We show how our field measurements of cloud droplet residuals, interstitial and below-cloud aerosol, and gas-phase isoprene oxidation products provide direct evidence for IEPOX-SOA formation in cloud droplets accompanied by heterogeneous OH radical oxidation. Single-particle mass spectra of atmospheric cloud residuals systematically diverge from laboratory and cloud-chamber IEPOX-SOA spectra, consistent with oxidative processing in real droplets during cloud cycling.

In MTU Pi Cloud Chamber experiments, we compare the temporal evolution of cloud droplets, wet aerosol particles, and cloud droplet residual size distributions during IEPOX uptake. We observe rapid, substantial IEPOX-SOA formation and particle growth that are strongest in cloud droplets, especially during droplet evaporation, indicating preferential aqueous-phase production during cloud processing. Controlled chamber studies further quantify how aerosol injection rate, sulfate seed acidity, and supersaturation influence the size and composition of individual wet aerosol particles and cloud droplet residuals during aerosol-cloud interactions.

A particle-resolved aerosol-cloud model including aqueous sulfate production and IEPOX-SOA chemistry reproduces the observed enhancement in cloud-residual size distributions during droplet evaporation and resolves distinct chemical regimes across the cloud cycle. Model results indicate that IEPOX-SOA forms most rapidly in evaporating droplets, faster than in cloud droplets and wet aerosol, consistent with field and chamber observations. Together, these results demonstrate that particle-scale variability and aerosol-cloud cycling jointly regulate IEPOX-SOA formation and oxidative evolution and provide process-level constraints for representing IEPOX chemistry in atmospheric models.

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6TA.2 – INVITED

Pop It Like It's Hot: Probing Organic Aerosol Viscosity One Particle at a Time. ANDREW P. AULT, Katherine Kolozsvari, Cara Waters, Madeline Cooke, David Bell, Natasha Garner, Jin Yan, N. Cazimir Armstrong, Alison Fankhauser, Yao Xiao, Rebecca L. Parham, Jens Top, Markus Ammann, Jason Surratt, *University of Michigan*

The phase state and viscosity of organic aerosol are critical determinants of mixing time scales within individual particles, which impacts heterogeneous reaction kinetics and product formation. Both secondary organic aerosol (SOA) and biomass burning organic aerosol (BBOA) are often mixed with inorganic species, which makes it difficult to predict their individual particle phase state based on ensemble average measurements, such as digital scanning calorimetry. Herein, we use nanothermal analysis (NanoTA), which uses a heated atomic force microscopy (AFM) tip to probe the melting temperature of individual particles. We use NanoTA to probe three important organic aerosol systems: isoprene epoxydiol (IEPOX) SOA, α-pinene + ozone SOA, and biomass burning. These measurements are then compared to established models converting bulk mass spectrometry data to viscosities and mixing time scales. For IEPOX SOA we show that at high relative humidity (RH) measurements and models agree well, but that below 50% RH models overpredict viscosity of the organic material. For α-pinene ozonolysis SOA we show that the presence of seed aerosol (no seed, ammonium sulfate, and Fe(II) ammonium sulfate) strongly impact the amount and composition of SOA forming, as well as the glass transition temperature. After UV aging, the viscosities converge towards a consistent and viscous state. Lastly, biomass burning aerosol with and without aging by ·OH radical show that ·OH oxidation leads to more viscous SOA. Together these results provide inside into the physicochemical changes that result for different important forms of organic aerosol, which has important implications for understanding their atmospheric behavior and impacts.

6TA.3

A 2D Polarity–Volatility Framework for Compound Classification and Automated Organic Aerosol Partitioning. ANDREAS ZUEND, Dalrin Ampritta Amaladhasan, Dan Barthaux, *McGill University*

Near-explicit mechanisms of tropospheric chemistry demonstrate that air parcels may frequently contain tens of thousands of organic compounds and reactions, posing a challenge for feasible atmospheric chemistry and air quality modeling. The level of chemical complexity that can be afforded in an atmospheric model is primarily constrained by computational costs, which typically call for substantial simplification. Sound methods are needed to transition from highly detailed to simple representations in a controllable manner. We introduce a new 2-dimensional (2D) polarity–volatility lumping framework that offers an automated classification of organic compounds and related reduction in the complexity of chemical systems. A main application of this 2D framework is the generation of mass-conserving and molecular-structure-aware data, serving as input for efficient gas–particle partitioning calculations using the Aerosol Inorganic–Organic Mixtures Functional groups Activity Coefficients (AIOMFAC) model. The 2D framework offers grid-based and cluster-based methods to determine an adjustable number of surrogate species. It offers flexibility in the choice of polarity axis, with pure-component vapor pressure serving as volatility axis. Aside from common choices like oxygen-to-carbon ratio as proxy for polarity, we also introduce a new polarity metric based on the ratio of a component's activity coefficients in water and an organic solvent (hexanediol). We show that this metric can be computed efficiently with AIOMFAC and that it encapsulates structure-based miscibility information that simpler proxies lack. Our tools automate the processing of thousands of compounds efficiently by using the Simplified Molecular Input Line Entry System (SMILES) description of molecular structures. We will demonstrate the application of the 2D framework for aerosol systems of hundreds to thousands of components. We show that tailored representations of gas–particle systems are possible and quantify how gradually changing the 2D resolution from high to low affects predicted SOA mass concentrations and physicochemical aerosol properties.

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6TA.4

Matrix Effects Reshape Organic Aerosol Volatility and Atmospheric Persistence. ALEXANDER LASKIN, Qiaorong Xie, Abigail Smith, Catalina Botero-Carrizosa, Steven Sharpe, Gali Dekel, Nicole June, ManishKumar Shrivastava, Yuqing Dai, Kevin Ridgway, Christian L'Orange, Shantanu Jathar, Katherine Hopstock, Sergey Nizkorodov, Yinon Rudich, *Purdue University*

Matrix effects in chemically complex organic aerosol (OA) mixtures markedly suppress the apparent volatility of individual species, causing substantial deviations from intrinsic, pure-compound-based volatility assumptions. When implemented in chemical transport modeling, these reduced volatilities lead to large increases in predicted biomass-burning OA mass loadings, extended atmospheric lifetimes, and enhanced regional transport. The results demonstrate that neglecting matrix effects can systematically underestimate OA burdens and their climate and air-quality impacts. Incorporating mixture-dependent volatility parameterizations is therefore essential for improving predictions by regional and global atmospheric models. Herein, we systematically investigate component-resolved, mixture-specific volatility for more than 1,500 individual species across 33 proxies and chemically complex mixtures representative of selected organic aerosol types. The results show that species in simplified proxies and reference mixtures with limited components follow a higher-volatility trend that approaches their intrinsic values, whereas species present in ambient and biomass-burning organic aerosols exhibit the opposite behavior, with systematically reduced apparent volatility attributable to matrix effects. Using levoglucosan (LG), a representative biomass-burning tracer, as an illustrative example, we find that its volatility in complex organic mixtures is reduced by 1-4 orders of magnitude relative to its intrinsic volatility in pure LG. This pronounced reduction underscores strong matrix effects that substantially suppress the apparent volatility of individual species in mixed systems. Machine-learning analysis further indicates that mixture-dependent molecular metrics are more predictive of apparent volatility than compound-specific molecular properties that define intrinsic volatility. Collectively, these findings highlight the critical role of intermolecular interactions in governing gas-particle partitioning in multicomponent systems. This study provides strong evidence that matrix effects significantly influence the apparent volatility of individual species in aerosols and other environmental organic mixtures and should be explicitly considered in volatility prediction frameworks and aerosol transport models.

6TA.5

Probing the Thermodynamics of Submicron Aqueous Aerosols Across Urban Pollution Gradients: Insights from Several Airborne NASA AQ Campaigns. PEDRO CAMPUZANO-JOST, Donna Sueper, Simon Clegg, Guy Symonds, Benjamin A. Nault, Dongwook Kim, Seonsik Yun, Douglas A. Day, Taehyoung Lee, Taehyun Park, Jihee Ban, Joonyoung Ahn, Gangwoong Lee, Katherine Ball, John Crounse, Paul Wennberg, Yunseo Choi, Mark Zondlo, Alessandro Franchin, Greg Huey, Armin Wisthaler, Jack Dibb, Meehye Lee, Josh DiGangi, Jose-Luis Jimenez, *University of Colorado Boulder*

The hygroscopicity and acidity of ambient aerosols are key intensive properties. They significantly affect aerosol physics, such as viscosity and phase state. They control the gas-particle partitioning of inorganic nitrogen and chlorine, with important implications for their atmospheric lifetimes. More generally, they modulate the thermodynamics and kinetics of many aqueous-phase and heterogeneous chemical reactions. Consequently, their accurate quantification is essential.

While aerosol pH and liquid water content (LWC) can be directly measured, current instrumentation, particularly for pH, remains ill-suited for fast ambient measurements. As a result, thermodynamic models are frequently employed to estimate these quantities, using gas and aerosol phase measurements as inputs. To quantify particle pH and ambient LWC, this study uses the Extended Aerosol Thermodynamics Model (E-AIM), specifically Model IV, via the new open-source AMbient Aerosol Thermodynamic calculator in Igor (AMATI) analysis tool. The tool was used for extended sensitivity analysis to quantify uncertainties.

Our analysis evaluates data collected over the last decade across several seasons in select North American and Asian megacities, including Bangkok, Seoul, Manila, and Los Angeles, during multiple NASA air quality focused airborne campaigns (ASIA-AQ, FIREX-AQ, and KORUS-AQ). Under fully constrained input conditions (gas and particle), E-AIM successfully simulated the observed partitioning of Cly, NOy, and NHx within combined uncertainties. Key findings from this dataset include: (1) large variations in average ALW and pH across different seasons and metropolitan areas; (2) consistent pH gradients at urban-exurban boundaries that influence Cly and NOy deposition; and (3) the significant role of organic ALW in driving some of these gradients as organic aerosol (OA) aging and hygroscopicity increase. This might also explain some of the observed model discrepancies in gas/particle partitioning.

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6TA.6

The Role of Relative Humidity for the Formation of Oxidized Shells on Aged Wildfire Particles. Johannes Passig, Ellen-Iva Rosewig, HASEEB HAKKIM, Mika Ihalainen, Anni Hartikainen, Markus Somero, Pasi Yli-Pirilä, Olli Sippula, Saara Peltokorpi, Kommula Snehitha M., Angela Buchholz, Annele Virtanen, Pauli Simonen, Ville Vakkari, Andreas Walte, Ralf Zimmermann, *University of Rostock*

Wildfire smoke strongly influences air quality, cloud pattern and the Earth system. During atmospheric aging, wildfire aerosol particles undergo complex chemical and microphysical transformations that alter their optical properties and cloud-forming ability. In particular, the formation of oxidized surface coatings can enhance light absorption through lensing effects while simultaneously increasing particle hygroscopicity.

Here, we present single-particle mass spectrometry measurements from a boreal wildfire smoke experiment, revealing the coexistence of hydrophilic oxidation products and hydrophobic polycyclic aromatic hydrocarbons (PAHs, brown carbon) within individual particles. We show that glyoxal and methylglyoxal are directly emitted during combustion and contribute to the initial hygroscopicity of freshly emitted smoke particles. During subsequent photochemical aging, rapid oxalate formation is observed together with a moderate increase in hygroscopicity, whereas PAH signals decay on substantially longer timescales. Similar degradation rates are found for different PAH species, but with a pronounced dependence on relative humidity, indicating that PAH loss is governed by viscosity-dependent radical diffusion within the particles. In contrast, highly oxidized products form much more rapidly, suggesting that these reactions are largely restricted to particle surfaces. At elevated relative humidity, surface oxidation persists throughout aging, whereas under dry conditions it rapidly diminishes. Together, these observations demonstrate the central role of relative humidity in controlling particle-phase reactivity, microphysical evolution, optical properties, and cloud activation potential in aged wildfire smoke.

6TA.7

From Molecules to Mixtures: Predicting Apparent Volatility of Complex Organic Systems with Deep Learning. Yinon Rudich, ALEXANDER LASKIN, Gali Dekel, *Weizmann Institute of Science*

Predicting and parameterizing the volatility of atmospheric organic aerosols for use in chemical transport models remains challenging because their observed behavior in the real world is governed by a complex interplay between compound-specific properties and interactions with the surrounding mixture. To address this challenge, we employ deep learning models to predict the volatility of individual species in complex organic aerosol mixtures and their laboratory proxies. Model inputs include experimentally measured apparent volatility for more than 1,500 species across 33 chemically diverse mixtures.We compare mixture-independent and mixture-dependent models, with the latter incorporating attention-based mechanisms to capture mixture-level interactions. The mixture-dependent models demonstrate improved predictive performance and stronger generalization, indicating that volatility is not solely an intrinsic molecular property but is strongly influenced by mixture context. The learned latent representations reveal a structured embedding space organized according to emission-source families and key physicochemical properties. This organization reflects the importance of matrix effects, including phase state, intermolecular interactions, and compositional heterogeneity, in governing volatility behavior. Overall, our results demonstrate that effective volatility emerges from a mixture context and provide a physically grounded framework for improving the prediction and parameterization of compound-specific volatility in complex organic aerosol systems.

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7AC.1

Gaseous and Aerosol Phase Products Resulting from NO3 Oxidation of Dimethyl Selenide. ERIN BOWEY, Linhui Tian, Lillian Tran, Stephanie Salas, Michael Lum, Ying Zhou, James F. Davies, Don Collins, Ying-Hsuan Lin, Roya Bahreini, *University of California, Riverside*

Once methylated selenium (Se) compounds, such as dimethyl selenide (DMSe), are emitted into the troposphere, they are subject to oxidative processing. Recent work exploring the daytime photooxidation of DMSe with OH or OH+NO_x reveals formation of lower volatility Se-containing species which can lead to new particle formation (NPF) and aerosol growth. However, nighttime oxidation of DMSe by NO_3 radicals has not been thoroughly studied. The present work investigates the gaseous and particulate products and the key properties of aerosol generated from DMSe oxidation in the dark by NO_3, comparing them to results from previous photooxidation experiments. An environmental chamber was used for all experiments to react DMSe with NO_3 generated from injected NO_2 and O_3. The reactions were monitored by a suite of on- and off-line techniques, including mAMS, SEMS, and (I^-)-ToF-CIMS with FIGAERO. DMSe oxidation with NO_3 yielded over 5-fold increase in SA mass concentration and a 1.8-fold larger mode diameter of the SA compared to the photooxidative conditions, under similar injected DMSe mixing ratios. Similar to photooxidation experiments, selenium dioxide (SeO_2) and selenous acid (H_2SeO_3) were produced and are suspected to be key for NPF, while selenic acid (H_2SeO_4), though expected, was not detected. Observed iodide adduct ions suggest formation of some species unique to NO_3 oxidation, such as gaseous HNO_3, likely produced from H-abstraction of DMSe by NO_3, along with CH_3SeNO_4, which may be $CH_3SeOONO_2$ or $CH_3Se(O)ONO_2$, and particulate methaneseleninic acid (CH_4SeO_2). To further identify products such as formaldehyde and hydroperoxymethaneselenoformate (HPMSeF), which are expected based on likelihood of the H-abstraction channel initiating NO_3 oxidation, carbonyl-targeted collection and analysis using DNPH-derivatization and OPSI-ESI-MS are planned. These results indicate that NO_3 oxidation of DMSe results in unique chemical pathways that influence the composition and properties of both gas and aerosol phase products.

7AC.2

New Insights Into Sulfur Oxidation Chemistry in the Troposphere Through Suspended Single Aqueous Aerosol Measurements. ADRIANE TAM, Vicki Grassian, *University of California San Diego*

Multiphase sulfur oxidation in aqueous aerosols plays an important role in atmospheric chemistry including acid rain and haze pollution, which significantly impact climate and air quality. Current atmospheric models often include kinetic parameters determined from laboratory measurements of bulk aqueous solutions. However, given the increased reactivity of aqueous aerosols compared to bulk solutions due to the high surface-to-volume ratio and the unique reactivity at the air–water interface, it is important that measurements be done on aqueous aerosols if they are to accurately reflect the chemistry of the atmosphere. Here we have taken a comprehensive approach to studies of sulfur oxidation chemistry in aqueous aerosols suspended in an Aerosol Optical Tweezer (AOT). We first accurately measure sulfur speciation, composition, pH, and charge of aqueous aerosols produced from bulk solutions utilizing different methods of analysis including cavity-enhanced Raman spectroscopy. Preparation of aqueous aerosols composed of S(IV) soluble species (SO_3^{2-} and HSO_3^-) from bulk solutions under N_2 show no oxidation, although the composition of individual aqueous aerosols was shown to be significantly different from the bulk solutions from which they were formed, especially at a solution pH below 6.0. In addition, enhanced partitioning of SO_2 from the aerosol was observed, which resulted in changes in the aerosol pH of several pH units. These findings under N_2 highlight the importance of quantifying parameters such as aerosol composition and pH to accurately study aerosol chemistry and kinetics. The oxidation of dissolved S(IV) can be observed in the absence of a catalyst when aqueous aerosols are exposed to O_2. The rate of oxidation of dissolved S(IV) is nearly 400 times faster in the aqueous aerosol compared to that in the bulk aqueous solution. Different environmental conditions (e.g. ionic strength and pH) are also explored to probe their impacts on uncatalyzed S(IV) oxidation to S(VI), in the form of sulfate. We will also discuss how the presence of chloride ions in the aqueous aerosol coupled with the enrichment of protons at the interface suggests a synergistic enhancement of the sulfur oxidation rate. In summary, our studies provide insights into sulfur oxidation chemistry when done within single aqueous aerosols that can be used to refine current atmospheric models.

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7AC.3

Four Years of TOF-ACSM Measurements at Rothera Research Station, Antarctica. Freya Squires, LEAH WILLIAMS, Tamazon Cowley, Evelyn Workman, Floortje van den Heuvel, Jonathan Witherstone, Amélie Kirchgaessner, Thomas Lachlan-Cope, *Aerodyne Research, Inc.*

A TOF-ACSM has been deployed at Rothera Research Station on Adelaide Island in Antarctica since 2022 as part of the UK NERC funded Southern Ocean Cloud (SOC) project. SOC aims to explain biases in surface radiation over the Southern Ocean in climate models due to inaccurate representation of clouds. The SOC project includes long term measurements at Rothera as well as short term intensive airborne and ship-based campaigns. The TOF-ACSM measures the chemical composition of sub 1 micron aerosol particles using thermal vaporization and electron impact ionization. Annual and seasonal cycles of sulfate, methane sulfonic acid and sea salt will be discussed. Comparisons with size distributions, with gas-phase dimethyl sulfide concentrations, and with air mass back trajectories provide information on sources and formation mechanisms.

7AC.4

Unraveling the Molecular Diversity and Atmospheric Origins of C1–5 Organosulfates Using Chromatographic Separation and Orbitrap Isotopomic Analysis. Shumin Liang, JIANZHEN YU, *Hong Kong University of Science & Technology*

Organosulfates (OSs) constitute a major fraction of organic aerosol and an important pool of aerosol sulfur, yet their molecular diversity and sources remain poorly constrained due to analytical limitations. Here we employ hydrophilic interaction liquid chromatography coupled with high-resolution Orbitrap mass spectrometry to achieve unprecedented molecular-level characterization of $C_{1–5}$ OSs in ambient aerosols. An integrated suspect screening and structural annotation approach identifies 289 $C_{1–5}$ OSs spanning 69 molecular formulas and eight functional groups from urban and suburban environments across three seasons in southern China. Our analysis reveals progressive oxidation patterns, with hydroxylated species dominating, followed by carboxyl/carbonyl-containing compounds characteristic of aged aerosols. Significant biogenic contributions are evident within these small OSs, including $C_{2–3}$ OSs oxygenated OSs, while $^{\delta 13}C$-depleted alkyl OSs exhibit distinct anthropogenic signatures. Spatial and temporal variations demonstrate how emissions, photochemical processing, and transport collectively influence $C_{1–5}$ OS distributions. Critically, we observe city-specific methyltetrol sulfate isomer patterns unexplainable by the established isoprene epoxydiols chemistry, suggesting underappreciated formation mechanisms mediated by aerosol acidity, liquid water content, and NO/NO_2 ratio. This molecular-scale framework bridges speciation with atmospheric processes, providing fundamental insights into biogenic-anthropogenic interactions that govern organic aerosol composition in complex real-world environments.

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7AC.5

Molecular Evidence for the Atmospheric Transformation of Trash Burning Aerosol Into Organonitrate- and Organosulphate-Rich Haze. AMNA IJAZ, Susan Mathai, Zezhen Cheng, Simeon Schum, Nurun Nahar Lata, William Kew, Claudio Mazzoleni, Lynn Mazzoleni, Swarup China, *Pacific Northwest National Laboratory*

Open burning of solid waste accounts for ~29% of global anthropogenic $PM_{2.5}$ emissions, yet its role in secondary aerosol formation during wintertime haze remains largely absent from current assessments. Using 21-Tesla Fourier transform-ion cyclotron resonance mass spectrometry, we show that fresh trash burning organic aerosol (tbOA) in the Indo-Gangetic plain of West Bengal, India, during wintertime is dominated by more volatile, low-oxygenation CHO species (66% of the formulae), including plastic and biomass combustion markers. Whereas the downwind ambient aerosol in haze was overwhelmingly composed of less volatile, highly oxygenated organonitrates and organosulphates (>85% of the formulae), demonstrating extensive atmospheric transformation. Single-particle micro-spectroscopy provides a mechanistic basis for this transformation, revealing that freshly emitted particles are internally mixed with inorganic hygroscopic components, facilitating aqueous-phase chemistry. These findings establish open trash burning as a major, overlooked source of secondary organonitrate and organosulphate-rich haze, highlighting that its chemical evolution must be further studied under controlled conditions and incorporated into atmospheric models.

7AC.6

Coal-Fired Power Emissions and Heterogeneous Chemistry Drive Delhi's Sulfate Pollution. RAKESH MAITY, Indranil Nandi, Ajit Kumar, Vikram Singh, Dilip Ganguly, Mayank Kumar, *Indian Institute of Technology Delhi*

The Indo-Gangetic Plain (IGP) experiences persistent air pollution, with wintertime conditions particularly severe. Urban centers such as Delhi frequently rank among the most polluted cities worldwide, where fine particulate matter ($PM_{2.5}$) dominates the air pollution burden. Sulfate constitutes approximately 9-12% of non-refractory $PM_{2.5}$ in Delhi; however, atmospheric models consistently underestimate its concentrations, both regionally and globally. This discrepancy reflects gaps in the representation of sulfate formation pathways as well as limitations in emission inventories, which often rely on global datasets that do not adequately capture regional emission characteristics and recent policy-driven changes in India.

Sulfate formation is typically attributed to gas-phase oxidation of SO_2 by OH radicals and aqueous-phase oxidation of S(IV) by oxidants such as O_3, H_2O_2, and NO_2, including transition metal ion (TMI)-catalyzed pathways. During winter haze episodes in Delhi, reduced solar radiation suppresses OH production, limiting gas-phase oxidation. At the same time, low aerosol liquid water content constrains conventional aqueous-phase chemistry. In contrast, elevated aerosol surface area under these conditions suggests an enhanced role for heterogeneous processes.

To address uncertainties in emissions, we updated a global emission inventory by incorporating region-specific energy-sector contributions and recent policy interventions. Model simulations using this revised inventory were evaluated against wintertime observations at IIT Delhi. While total sulfur was well reproduced (NMB ~1.3%), sulfate concentrations remained underestimated. We then assessed multiple sulfate formation pathways relevant to haze conditions (e.g., H_2O_2 and NO_2 pathways). Our results indicate that metal-catalyzed heterogeneous oxidation of SO_2 by O_2 on aerosol surfaces is the dominant pathway, contributing ~43% of observed sulfate. Inclusion of this mechanism substantially improves agreement between model and observations. Further analysis using a Lagrangian framework shows that this pathway is strongly pH-dependent, with enhanced sulfate production occurring at aerosol pH between 4 and 5. In addition, regional transport plays a critical role, with a significant fraction of sulfate formed from emissions originating from coal-fired power plants in neighboring states.

Overall, our findings demonstrate that wintertime sulfate pollution in Delhi is controlled by the combined effects of regional coal-based emissions and heterogeneous oxidation on aerosol surfaces. These results underscore the importance of improving both emission inventories and chemical mechanisms to accurately represent sulfate formation in severely polluted environments.

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7ES.1

Real-Time Chemical Speciation and Source Apportionment of Ambient PM2.5 with the AIRMon Automated FTIR Monitor.
NIKUNJ DUDANI, Andrea Baccarini, Satoshi Takahama, *Aerospec SA*

Chemical speciation of fine particulate matter (PM2.5) is critical for source identification, air quality management, and exposure assessment. Aerospec SA presents the Aerosol InfraRed Monitor (AIRMon), an automated online FTIR-based instrument that delivers chemically-resolved PM2.5 composition at sub-daily time resolution in a deployable, low-maintenance format. The AIRMon couples continuous aerosol collection with sequential FTIR transmission spectroscopy, producing a spectral time series from which a wide range of PM2.5 components can be quantified from a single measurement, including organic functional groups, inorganic ions, mineral dust, and secondary sea spray.

This showcase will demonstrate the AIRMon's capabilities for online chemical speciation and source apportionment using results from its deployment at the National Observatory of Athens (NOA), Greece, during March to April 2025, where the instrument operated unattended at 4-hour resolution. We will show how non-negative matrix factorization (NMF), applied to the AIRMon spectral dataset using the U.S. Environmental Protection Agency (EPA) Environmental Source Apportionment Toolkit (ESAT), resolved six source factors: ammonium sulfate (AS), ammonium nitrate (AN), mineral dust, fresh and aged biomass burning (BB) organic aerosol, and secondary sea spray. The 4-hour sampling resolution enabled the reconstruction of factor-specific diurnal cycles and directional source signatures, providing actionable source information at high temporal resolution.

The AIRMon brings lab-grade aerosol chemical speciation and source apportionment to automated field monitoring, supporting air quality networks, research campaigns, and regulatory programs.

7ES.2

From Indoor Air to Clouds: Real-Time Holographic Imaging and AI-Based Characterization of Airborne Particles.
JIARONG HONG, *Particle4X, Inc.*

Conventional aerosol instruments commonly measure particle concentration and size but provide limited direct information on individual particle morphology and type. Particle4X has developed three holographic imaging instruments that extend real-time particle characterization from indoor environments to long-term field monitoring and in-cloud measurements. Each instrument uses digital inline holography to record particles within a three-dimensional sample volume and AI-assisted analysis to determine particle concentration, size, morphology, and type.

HoloAir is a compact, integrated platform for indoor and occupational air-quality monitoring. It combines real-time imaging and classification of coarse particles with complementary measurements of particulate matter, carbon dioxide, volatile organic compounds, and environmental conditions.

HoloCMA is designed for high-throughput characterization of coarse-mode atmospheric aerosols, including pollen, fungal spores, dust, and sea spray. Active-flow and passive open-path configurations support a range of laboratory and field applications. Onboard processing and selective storage of detected-particle images enable standalone operation, while wireless connectivity and an integrated cloud service support remote instrument access, data transfer, system monitoring, live and historical data visualization, particle review and labeling, and coordinated oversight of distributed deployments.

HoloCloud is a lightweight, rugged, open-path instrument for direct measurement of cloud particles. Designed for integration with uncrewed aerial vehicles, it supports in situ characterization and phase discrimination of liquid droplets and ice particles in cold, wet, and rapidly changing cloud environments. Integrated heating and thermal control help prevent condensation on the optical windows and maintain measurement performance under challenging atmospheric conditions.

The showcase will include live demonstrations of hologram acquisition, three-dimensional particle reconstruction, and automated analysis across the three platforms. Attendees will explore practical measurement workflows for indoor air quality, bioaerosol and dust monitoring, atmospheric field campaigns, and cloud microphysics. The session will demonstrate how morphology-rich, label-free imaging can complement conventional concentration and size measurements while enabling compact, autonomous, and remotely operated aerosol observations.

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7IA.1

Moisture-Mediated Connections Between Fungal Gene Expression and Microbial Volatile Emissions in Indoor Dust and Carpet. Neeraja Balasubrahmaniam, Sumaiya Hassan, Emma Hall, Bridget Hegarty, Pawel K. Misztal, Allen Goldstein, Rachel I. Adams, Karen C. Dannemiller, SARAH HAINES, *The Ohio State University*

Indoor dampness and mold are associated with increased asthma and respiratory disease risk, and one of the strongest associations with health effects is presence of moldy odor. Moldy odor comes from microbial volatile organic compound (mVOC) emissions produced during fungal primary and secondary metabolic processes. However, mVOC measurements are an unreliable quantitative indicator of dampness, highlighting the need for improved microbial indicators of indoor mold growth such as fungal metabolic activity. VOC measurements paired with de novo metatranscriptomic analysis were performed using house dust and dust in carpet, incubated in laboratory chambers at different equilibrium relative humidity (ERH) for 14 days. Gene expression and mVOC emissions were both significantly associated with moisture (adonis2 p=0.001) with mVOC emissions showing significant differences (adonis2 p=0.001) between dust and dust with carpet. Fungal growth functions related to sporulation (GO:0043934, GO:0030435, FDR q <0.01) were enriched at elevated ERH compared to 50% and also significantly enriched (FDR q<0.001) in dust compared to dust with carpet. mVOCs such as C10H16H+ (monoterpenes, log2FC=15.764, FDR q =0.011) were emitted more frequently at elevated ERH compared to 50%, with C6H10O2H+ (heptanone, log2FC=1.17, FDR q =0.005) most significantly associated with dust. Significant associations between pairs of growth and secondary metabolic genes and mVOCs were found (n=19) with the fungal terpenoid metabolism gene flvB highly correlated with C8H14OH+ (Octenone, ρ=0.98, FDR q <0.001). Our results demonstrate that linking fungal metabolic activity to mVOC emissions can inform the development of more robust, function-based indicators of mold damage and potentially identify specific metabolic pathways underlying moldy odor and associated health effects in damp homes.

7IA.2

Formation of Large Amines as Potential New Particle Nuclei During 222 NM Photolysis of Quaternary Ammonium Compounds. TYSON BERG, Taehyun Park, Morgan Selby, Jose Hernandez, Jienan Li, Delphine K. Farmer, *Colorado State University*

Quaternary ammonium compound (QAC) cleaners and 222 nm germicidal ultra-violet light devices (GUV_{222}) are technologies growing in application, due to the increased focus on indoor disinfection; each with unclear and under-examined impacts on indoor air quality. Certain QACs can photolyze in the UV to produce neutral organonitrogen compounds, which tend to be fast 222 nm absorbers compared to most other organic moieties. If these two disinfection methods are used simultaneously, there is potential for compounding air quality impacts.

We conducted QAC cleanings in a real office space and identified new particle formation events following application under GUV_{222}. Using a chemical ionization mass spectrometer with iodide reagent ions, we identified formation of large amines in the gas phase when GUV_{222} was applied directly over standing liquid of QAC commercial cleaners and a QAC standard in water. The large amines were found at masses greater than 220 au and would be approximately 2 nm in scale, making them ready nuclei for the formation of particles in the office cleaning experiments. Our results suggest new particle formation from surface photolysis of QACs during cleaning under GUV_{222}.

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7IA.3

Behaviors of Chlorinated Compounds from Indoor Hypochlorous Acid Cleaning and the Influences from Germicidal UV Lights. QING YE, Matt Shulman, Sofie Schwink, Rebecca Mesburis, Andre Schaum, Seonsik Yun, Rileigh Robertson, Douglas A. Day, Anne V. Handschy, Kyle Zarzana, Kelvin Bates, Joost A. de Gouw, Marina Vance, Jose-Luis Jimenez, *University Corporation for Atmospheric Research*

Indoor air cleaning has attracted increased attention since the COVID-19 pandemic. For example, hypochlorous acid (HOCl) fogging was widely used for its strong sanitizing properties, especially in clinical practices. Germicidal ultraviolet (GUV) lights have become increasingly popular due to their ability to inactivate airborne pathogens. However, these air-cleaning methods chemically perturb indoor environments, and their impacts on indoor air quality are not yet well understood.

In this study, we measured gaseous chlorinated compounds and chloride aerosols during chlorine-based air cleaning events using a suite of real-time analytical instruments as part of the CLEAN Home Field Study. The study took place in a residential home in Boulder, Colorado, in summer 2025. We compared chlorinated compounds in two types of cleaning events: 1) wiping surfaces with sodium hypochlorite bleach (bleach wiping) and 2) spraying HOCl solution in the air via a commercial fogging device (HOCl fogging). An observationally-constrained kinetic model was used to describe the physical and chemical processes during the cleaning events.

During bleach wiping, we observed elevated levels of a broad range of gaseous chlorinated compounds including Cl2, HOCl, ClNO2 and chloramines. Their abundances and temporal behaviors can be explained by the modeled multiphase chlorine chemistry. HOCl fogging produced similar chlorinated compounds, but their concentrations in indoor air persisted for shorter periods compared to bleach wiping. In addition, HOCl fogging generated a large amount of aerosol particles whereas bleach wiping only caused small aerosol increases. In both types of events, surface deposition of gaseous chlorinated compounds was found to be a more important removal pathway than ventilation and photolysis. When the cleaning events were coupled to GUV, both model and measurements showed negligible changes in chlorinated compound concentrations. The model showed moderate increases in oxidant (OH and Cl) production. Lastly, we found that operating GUV222 or GUV254 without bleach wiping or HOCl fogging led to increased levels of several chlorinated compounds that cannot be explained by the current mechanisms in the model, and therefore warrant further research. By studying the fates of chlorinated compounds and other species, this work improves our understanding of the indoor air quality impacts from chlorine-based and GUV air cleaning.

7IA.4

Rapid Secondary Organic Aerosol Formation from Volatile Chemical Product Sprays Under Indoor Ozone Levels in Laboratory Space. SIJIA LIU, Amna Ijaz, Kieudiem Nguyen, Meredith Schervish, Meghan C. Guagenti, Zezhen Cheng, Manabu Shiraiwa, Celia Faiola, Sergey Nizkorodov, Alla Zelenyuk, *Pacific Northwest National Laboratory*

Volatile chemical products (VCPs) are increasingly recognized as major indoor sources of reactive organic vapors, yet secondary organic aerosol (SOA) formation from VCP use under realistic indoor ozone and ventilation conditions remains poorly characterized. We report observations of new particle formation (NPF) and SOA growth triggered by a brief application of a d-limonene-based cleaner in a furnished, well-ventilated laboratory with no added oxidants and typical indoor ozone level (~30 ppb). The spray produced localized ppm-level limonene and immediately triggered NPF and rapid particle growth. Particle mass concentrations reached ~200 μg m^{-3} within ~15minutes, with growth rates of 600-900 nm h^{-1} substantially higher than commonly observed outdoors despite a high air exchange rate (AER = 6.8 h^{-1}). Multiple NPF bursts occurred following the initial event, consistent with a dynamic competition between condensable vapor production and removal of pre-existing particles by ventilation and deposition that intermittently reduced the condensation sink.

Single-particle mass spectrometer (miniSPLAT) showed a shift to predominantly spherical, organic-rich particles after spraying. Offline high-resolution mass spectrometry revealed abundant ultra/extremely low-volatility organic compounds (ULVOC/ELVOCs), including highly oxygenated molecules (HOMs) and oligomers. We then used a box model to simulate the NPF events, resolve size-dependent condensation and coagulation loss pathways, and showed that, consistent with the observations, lower ventilation sharply increases particle number, growth, and persistence. These results demonstrate that routine terpene-based VCP spray use can generate unexpectedly intense indoor SOA and repeated NPF even in highly ventilated laboratory environments, highlighting ventilation and mixing as key factors of exposure-relevant particle concentrations.

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7IA.5

Spatial and Seasonal Variation of Indoor – Outdoor PM2.5 Exposures and Its Chemical Composition in Urban Residents Across Four Cities in India. CHAITANYA B. SHIVAKUMAR, Rajdeep Singh, Akshay Kumar, Vinayak Sahota, Harish C. Phuleria, *Indian Institute of Technology Bombay*

Adolescents in India, a population particularly vulnerable to $PM_{2.5}$-related health effects, spend ~ 80% of their time indoors, yet indoor exposures in urban residential environments remain unexplored. Under the APEAL (Longitudinal effects of Air Pollution Exposure on Adolescents' Lungs) project, this study quantifies indoor $PM_{2.5}$ and its chemical composition across 12–17 households per city in Delhi, Mumbai, Bengaluru, and Mysuru, sampled in winter and summer using low-volume samplers on 47 mm PTFE filters, with IC for water-soluble inorganic ions, ICP-MS for trace metals and acellular assay - ascorbic and DTT for examining aerosol oxidative potential.

Indoor $PM_{2.5}$ showed a clear inter-city gradient during winter (Delhi: 303 µg m^{-3}, significantly higher than Mumbai: 149, Bengaluru: 95, and Mysuru: 49 µg m^{-3}; $p < 0.001$). Winter concentrations were significantly higher than summer ($p<0.001$) in Delhi (2.5*x*), Mumbai (2.4*x*), and Bengaluru (1.7*x*); Mysuru showed no significant seasonal difference. Indoor-to-outdoor (I/O) ratio > 1 in several households across seasons - importance of indoor emission sources - cooking and resuspension.

Chemical composition revealed a dual narrative of outdoor infiltration and city-specific indoor sources. Secondary aerosols (SO_4^{2-}, NO_3^-, NH_4^+) constituted 30% and 21% of indoor $PM_{2.5}$ mass in Delhi and Mumbai, respectively, with I/O ~1, suggesting outdoor infiltration; SO_4^{2-}/NO_3^- ratios of 1.12 and 2.26 reflect combustion source signatures. Traffic-related Zn and Pb were present indoors across all cities (I/O: 0.8–0.9). Species with I/O > 1 identified distinct indoor source signatures: Ni (2.79) and As (1.87) in Delhi suggest indoor combustion; Se (1.75) and K (1.42) in Mysuru indicate solid fuel burning; and Ca and Mg in Bengaluru point to dust resuspension.

Oxidative potential measurements reveal a toxicological dimension. Mumbai's indoor OP^{AA} (0.68 nmol min^{-1} m^{-3}) was ~7x Bengaluru, with indoor exceeding outdoor (I/O = 1.50) — consistent with its elevated Cu and Mn burden from an indoor metal-rich source. Delhi had the highest absolute indoor OP^{DTT} (4.19 nmol min^{-1} m^{-3}), possibly due to carbonaceous aerosol infiltration; in Mysuru, indoor OP^{DTT} > outdoor (I/O = 1.79), suggesting solid-fuel burning as an active source of redox-active particles indoors.

These results highlight that indoor $PM_{2.5}$ in Indian cities has a unique chemical profile influenced by outdoor infiltration and indoor activities, with notable seasonal and spatial variations.

7IA.6

Characterizing Indoor PM2.5 and PM10 in Utah K-12 Schools: Spatial, Temporal, and Occupancy-Driven Patterns. JIMMY DIMPOR, Tristalee Mangin, Kerry Kelly, Ryan Thalman, Nancy Daher, *University of Utah*

Poor indoor air quality (IAQ) is a growing concern in schools. Children are particularly susceptible to particulate matter (PM)–related health effects, with elevated exposures linked to respiratory symptoms, increased absenteeism, and reduced academic performance. To characterize indoor PM levels, we conducted a multi-site monitoring study across 15 K–12 schools in urban and rural Utah with diverse building characteristics and ventilation systems. Paired indoor–outdoor $PM_{2.5}$ (Plantower PMS5003), PM_{10} (Alphasense OPC-N3) and CO_2 (Senseair Sunrise HVAC) were measured continuously using low-cost sensor nodes. Indoor $PM_{2.5}$ and PM_{10} concentrations varied across schools, with generally higher levels observed during weekdays compared to weekends, consistent with increased occupancy and indoor activity. PM_{10} exhibited greater variability than $PM_{2.5}$ across classrooms, reflecting the influence of resuspension during occupied periods. Excluding periods affected by wildfire smoke and temperature inversions, indoor $PM_{2.5}$ concentrations were typically lower than concurrent outdoor levels. However, during these events, indoor $PM_{2.5}$ increased and closely tracked outdoor concentrations. During the study period (August 2025–January 2026), indoor $PM_{2.5}$ concentrations exceeded the World Health Organization (WHO) 24-hour guideline (15 µg/m^3) at only two schools. Schools with elevated CO_2 concentrations also tended to exhibit higher PM_{10} levels, suggesting that occupancy-related activity and ventilation effectiveness influence indoor PM accumulation. These findings highlight the combined influence of indoor activities and outdoor pollution on school IAQ and can inform targeted interventions to improve air quality in school environments.

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7IM.1

An Electrodynamic Trap for the Study of Aerosol Nanoparticles. JULIE PONGETTI, Adam Boies, *Stanford University*

Since their first introduction 70 years ago, particle traps have enabled significant advances across scientific disciplines from particle physics to chemistry and biology. Radiation pressure (light) or AC electric fields are used to trap both atoms (or charged ions) and microparticles, but little work has been reported on the possibility of trapping large numbers of airborne particles measuring from about five to hundreds of nanometers. Trapping of sub-micron particles is particularly complex at ambient temperature and pressure, where the high surface-area-to-volume ratio causes an increase of the drag force relative to the focusing field and Brownian motion cannot be neglected.

We argue that traditional stability criteria used in quadrupole mass spectrometers and electrodynamic balances, which do not account for Brownian motion, do not fully capture the behavior of sub-micron particles in the alternating electric field, and propose a new stability analysis based on energy considerations. The large drag-to-mass ratio pushes typical operating points far away from the traditional stability boundaries, further reducing the usefulness of the typical parametrization. Analytical solutions and numerical simulations are combined to identify a stability criterion and obtain the trapping requirements and achievable trapping density as a function of particle properties and gas conditions.

Based on these findings, a linear trap design is proposed which allows real-time optical characterization of the contained particles as environmental conditions (e.g., temperature, RH, gas composition) are varied.

7IM.2

Field Evaluation of the Spider-MAGIC Bipolar, Scanning Mobility Particle Size Analyzer. Stavros Amanatidis, Arantzazu Eiguren-Fernandez, Gregory S. Lewis, SUSANNE HERING, Haroula D. Baliaka, Purushottam Kumar, John Seinfeld, Richard Flagan, Bradley Ries, Roya Bahreini, Sean Raffuse, Ann M. Dillner, Armistead G. Russell, Nga Lee Ng, *Aerosol Dynamics Inc.*

In this work we report on the long-term field performance of a new, fast, compact dual-polarity mobility system called Spider-MAGIC. Spider-MAGIC is a scanning electrical mobility sizer that combines the “Spider” radial-flow Differential Mobility Analyzer (DMA) (Amanatidis et al., 2020), and the “MAGIC” water based Condensation Particle Counter (CPC) (Hering et al., 2019) into a compact, fully integrated, dual-polarity system (Model 810, Aerosol Dynamics Inc). It has been operating alongside a TSI Scanning Mobility Particle Sizer (SMPS) at the Pico Rivera and Rubidoux sites of the ASCENT monitoring network in Los Angeles. Additionally, total number concentrations were measured with a TSI 3783 water-CPC and three ADI community CPCs (Hering et al., 2025).

The two electrical mobility sizing instruments, Spider MAGIC and the TSI SMPS, show good agreement in both the reported mean particle size and number concentration over their overlapping size range (13 500 nm). A strong correlation is also observed between the total number concentration from the Spider-MAGIC and the condensation particle counters.

The Spider-MAGIC automatically alternates between positive and negative polarity scans. Thus the positive-to-negative ion mobility ratio (Z+/Z−) can be inferred from the raw data (Chen and Jiang, 2018). We find that this ratio varies over time from 0.725 to 0.801, and is lower than the fixed 0.875 value employed in the widely-used approximation by Wiedensohler (1988) for radioactive chargers.

This work was supported by the US Department of Energy under SBIR grant DE-SC0022440, and by the National Science Foundation grants AGS-2131914 and AGS-2512186.

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7IM.3

Advancing In-Situ Airborne Microphysical Measurements of Aviation Emissions During ecoDemonstrator. MATTHEW BROWN, Steven Baughcum, Francesca Gallo, William M. Griffin, Michael Shook, Edward Winstead, Luke Ziemba, Richard Moore, *NASA Langley*

Aerosol particles, particularly those from aircraft emissions, play a critical role in modulating Earth's radiative balance through the direct scattering of light and the formation of contrail cirrus clouds. However, the precise impact of aviation on climate forcing remains uncertain. To better understand these processes and improve global climate models, high-quality airborne measurements of aircraft emission microphysical properties are essential.

We present a novel technique to measure ultrafine monodisperse aerosol size distributions using high-altitude particle counters from the NMASS towards the application of aircraft emission measurements. The instrument package was deployed during the 2023 NASA collaboration with the Boeing ecoDemonstrator program. During these research flights, the NASA DC-8 sampled engine exhaust emitted by a Boeing 737-10 to compare the effects of sustainable aviation fuel (SAF) versus conventional jet fuel over the northwestern US. This presentation will discuss the NMASS instrument capabilities and novel data reduction algorithms, alongside unique observations from the ecoDemonstrator flights. We will highlight the variations of key volatile and nonvolatile microphysical exhaust parameters as a function of different jet fuel compositions and engine conditions.

7IM.4

Simultaneous Hyperspectral Imaging and Pyrometry for Aerosol and Vapor Temperature Profiling During Combustion. MICHAEL ZACHARIAH, Qinghui Meng, *University of California, Riverside*

High-temperature, multi-phase reactions (aerosol and vapor) present significant challenges in understanding their chemical processes and underlying mechanisms. These systems often involve rapid, heterogeneous reactions which require temporally and spatially resolved diagnostic tools. To address this need, this work develops a dual-camera system that integrates hyperspectral emission spectroscopy and three-color pyrometry, enabling simultaneous, high-speed measurements of gas-phase and condensed-phase temperatures. One camera captures RGB video for three-color pyrometry, while the other captures emission spectra using a slit-array mask and diffraction grating system. The slit-array mask is designed to achieve spatial coverage, allowing for 2D gas-phase temperature profiling. Gas-phase temperatures are derived using emission spectra based on Boltzmann equation, utilizing the intensity ratios of potassium emission lines near 580 nm and 693 nm. Demonstration experiments were conducted using 3D-printed Al-KClO4 thermites with varying equivalence ratios, revealing maximum gas-phase temperatures of 3300-3700 K, and condensed-phase temperatures about 2800 K. The gas-phase temperatures closely align with the material's adiabatic flame temperatures, and the condensed phase temperatures of aluminum droplets are close to aluminum boiling point (2743 K). This diagnostic system offers significant advancements in the study of energetic materials by enabling synchronous, high-speed measurements of gas-phase and condensed-phase temperature distributions. Its capability for 2D profiling and adaptability to other high-temperature reaction systems represents a critical step forward in advancing fundamental research on energetic materials and combustion. The outcome of this work lays the foundation for exploring thermal dynamics and chemical kinetics in energetic composites, facilitating the design of nanostructured energetic materials.

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7IM.5

Revisiting Fine Particle Size Distribution Extraction. JIANI YANG, Purushottam Kumar, Vine Blankenship, Haroula D. Baliaka, Georgia Argyropoulou, Stavros Amanatidis, Susanne Hering, Nga Lee Ng, Richard Flagan, *California Institute of Technology*

Continuous measurements of fine-particle size distributions within the Atmospheric Science and Chemistry Measurement NeTwork (ASCENT) have prompted a detailed examination of the data inversion used in the TSI Aerosol Instrument Manager (AIM) software analysis of scanning mobility particle sizer (SMPS) data. This software assumes that the instrument response to a monodisperse aerosol, i.e., the transfer function, is triangular as derived for a differential mobility analyzer (DMA) operated at constant voltage for particles that migrate under the action of the applied electric field, but do not diffuse. Diffusion broadens the instrument response for small particles, and the exponential voltage ramp used in the SMPS further distorts the transfer function. Furthermore, the finite response time of the condensation particle counter (CPC) (or other detector) delays particle transmission from the DMA outlet to the detection point within the CPC, leading to counts being distributed over a number of later time bins according to a residence time distribution function. We examine the effects of these distortions of the instrument response simulated experiments using models of the same instrument. To determine the extent to which the varying degrees of approximation may affect the inferred aerosol dynamics, we incorporate the different transfer functions into our model, and perform data inversions both without and with noise resulting from Poisson counting statistics and other sources. We employ an established constrained regularization algorithm for the data inversion. Real-world measurements require accounting for particle losses and other biases in each of the components of the sampling system upstream of the instrument. We explore these additional perturbations and their effects on the air quality data inferred from SMPS and other particle instruments at the ASCENT measurement station in Pico Rivera, CA. The software employed in this analysis will be made available via GitHub.

7IM.6

A Protocol for Merging Mobility and Aerodynamic Measurements of Solid Aerosol. MIRANDA HACK, Darren Cheng, V. Faye McNeill, *Columbia University*

Characterizing solid aerosol that ranges in size between several hundred nanometers and several microns in physical diameter presents a unique challenge, with the number distribution often extending beyond either the high or low limit of commonly used sizing instruments. While instruments measuring mobility diameter do not measure D_{mob} > ~800 nm and struggle in the presence of larger, multiply charged particles, aerodynamic sizing instruments often have a lower limit of ~550 nm. These two categories of instruments also measure different quantities — D_{mob} and D_{aer} — which differ from the true D_{ve} for a non-spherical, non unit-density solid particle. Using a set of experiments we call “tandem DMA-APS”, we infer the relationship between D_{mob} and $D_{aer,}$ giving insight into the dynamic shape factor and effective density of solid aerosol, which varies across the size range. This is then incorporated into a novel merging algorithm for mobility and aerodynamic-based instruments (here, SMPS and APS), which includes multiple charge correction for particles detected by the APS above the largest SMPS size bin. This protocol also accounts for variations in particle shape and density that make characterizing solid aerosol particularly challenging using existing algorithms. The result yields cohesive SMPS-APS measurements as well as a more rigorous representation of solid aerosol surface area for laboratory kinetic experiments

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7SA.1

Chemical Characteristics of PM1 and Secondary Aerosol Formation Driven by Local Chemistry and Regional Transport at a Coastal Site in Korea. JIHYE MOON, Kyung-Duk Zoh, Hwajin Kim, *Seoul National University*

Real-time measurements of submicron aerosols were conducted at the Anmyeondo Climate Change Monitoring Station, a coastal site in western Korea, from January to March 2024 as part of the ASIA-AQ campaign. The average PM_1 concentration was 21.4 μg m^{-3} (range: 0.8–101 μg m^{-3}), indicating strong temporal variability. Compared with Seoul, Anmyeondo exhibited a higher $PM_{2.5}/PM_{10}$ ratio (0.65 vs. 0.60), which further increased during haze episodes (0.72–0.74), suggesting enhanced secondary aerosol formation. Consistently, secondary components accounted for ~78% of PM_1 mass, while primary emissions contributed ~22%.

Positive matrix factorization identified primary sources (HOA, BBOA) and secondary sources (LO-OOA, MO-OOA), alongside a distinct marine organic aerosol (MOA) factor. Two major haze events were observed, driven by nitrate enhancement but governed by different pathways: one via aqueous-phase and nocturnal N_2O_5 chemistry under humid conditions, and another under stagnant, photochemically active conditions.

Notably during the Lunar New Year period (12–14 February), despite prevailing southerly winds, the air mass was overwhelmingly dominated by highly oxidized OOA with a remarkable lack of fresh primary tracers. This chemical signature suggests a "return-flow" mechanism, where regionally transported pollutants stagnated and extensively aged over the Yellow Sea before advecting onshore.

Overall, these findings challenge the conventional classification of Anmyeondo as a pristine background receptor. Instead, it functions as an "active coastal chemical reactor" where the convergence of long-range transported aerosols, regional anthropogenic emissions (e.g., from nearby power plants), and abundant marine moisture synergistically accelerates secondary aerosol formation. This underscores the need for regional air-quality strategies targeting complex multi-source mixing at land-ocean interfaces.

7SA.2

Regional Transport and Biogenic Influences on Ultrafine Particle Composition in the Mojave Desert. KRISTEN CRAMER, Sanjeevi Nagalingam, Alex Guenther, James Smith, *University of California, Irvine*

The California deserts are recognized as vulnerable ecosystems due to their sensitivity to climate change, with projections indicating rising annual temperatures, more extreme weather patterns, and shifts in seasonal precipitation. Because water availability is a limiting factor in arid environments, these changes are expected to produce cascading ecological and atmospheric effects. The Mojave Desert is distinctive among U.S. deserts as a high-altitude desert influenced by transport from urban and coastal regions, which interact with biogenic emissions from its unique endemic vegetation. Previous studies have linked transported ozone and anthropogenic pollutants to the formation and growth of ultrafine particles in California deserts, with frequent events observed during summer despite extreme temperatures. To better understand particle composition and growth mechanisms in this region, a field campaign was conducted in an ecosystem containing piñon – juniper woodland and montane chaparral at the Burns Piñon Ridge Reserve in July 2024. Ultrafine particles were collected on filter samples for compositional analysis using high-resolution mass spectrometry, alongside measurements of meteorology, ozone, gas-phase biogenic volatile organic compounds (BVOCs), and particle size distributions. Ultrafine particle events were observed on 35% of days, with an average growth rate of 7.5 ± 1.4 nm/hr. Ozone mixing ratios, air mass back trajectories, and meteorological data indicate highly efficient transport from coastal and urban areas. Particle composition analysis reveals substantial contributions from methanesulfonic acid and organosulfates, and highly oxidized, extremely low-volatility organic compounds, demonstrating the importance of coastal and urban transport respectively. Quantification of gas-phase BVOCs demonstrates abundant isoprene and a diverse suite of terpenes likely to interact with anthropogenic ozone and enhance particle growth. These results advance understanding of aerosol composition and growth in desert environments and highlight the importance of anthropogenic–biogenic interactions in shaping atmospheric chemistry in remote regions.

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7SA.3

Source Apportionment and Temperature Dependence of Secondary Organic Aerosol in New York City. RUIZHE LIU, Yutong Liang, Sophia Hoch, Tianchang Xu, David Pando Gonzalez, Taekyu Joo, Anandi Williams, Mitchell Rogers, Mia Tran, Manaka Ogura, Megan Claflin, Daniel C. Blomdahl, Brian Lerner, Joseph Roscioli, Pawel K. Misztal, Drew Gentner, Nga Lee Ng, *Georgia Institute of Technology*

Organic aerosols (OA) are a major component of urban fine particulate matter and can be strongly influenced by temperature through changes in precursor emissions and secondary formation. This temperature dependence is especially important in dense urban environments such as New York City, where global warming and urban heat island effects may increase human exposure to secondary organic aerosol (SOA). To investigate the sources and temperature sensitivity of urban SOA, we analyzed measurements from the City University of New York (CUNY) site during the Atmospheric Emissions and Reactions Observed from Megacities to Marine Areas (AEROMMA) field campaign from July 13th to August 16th, 2023. The high-resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS) is deployed for measuring non-refractory submicron aerosols. A Filter Inlet for Gases and AEROsols coupled to a High-Resolution Time-of-Flight Chemical Ionization Mass Spectrometer (FIGAERO-CIMS) is also deployed to characterize speciated organics at the molecular level.

The positive matrix factorization (PMF) of the AMS and FIGAERO-CIMS data identifies multiple OA factors, including oxygenated OAs, cooking-related OA, hydrocarbon-like OA, and biomass-burning oxygenated OA (BBOOA). The BBOOA factor shows consistent temporal variation with biomass burning external tracers, including carbon monoxide, black carbon, and potassium. By integrating bulk aerosol, molecular-level, and external tracer information, this work improves the source apportionment of urban aerosols beyond what can typically be achieved using AMS alone. Specifically, the combined AMS-FIGAERO-CIMS framework provides new molecular constraints on anthropogenic SOA and supports the identification of major chemical components. Our results further suggest that anthropogenic SOA contributes substantially to the observed aerosol temperature dependence. These findings highlight the importance of a multi-instrument approach to resolve complex urban OA sources and that targeted control of key anthropogenic emissions could further reduce aerosol burden in the New York City area.

7SA.4

A Multi-Dimensional Approach to Aerosols: Geospatial Mapping, Chemical Fingerprinting, and Statistical Modeling of Airborne and Settled Dust in an Urban Centre, Karachi - Pakistan. Saiyada Shadiah Masood, HAIDER KHWAJA, Sumayya Saied, Muhammad Kamran Khan, Ghania Quadri, Farozan Umar, *University at Albany*

Aerosols, size ranging from a few molecular species to visible dust particles, originated from natural and anthropogenic sources. These particles are generated through coagulation and sedimentation of particulates originating from physico-chemical reactions in the atmosphere. Dust comprises of both respirable and irrespirable fractions of airborne aerosols. Chemical profiling of such airborne and settled particles is a critical issue in terms of air quality and eventually human exposure. Epidemiological investigations supported that exposure to particulate matter (PM) causes harmful pulmonary and cardiovascular health risks. Samples were collected to assess the concentration (mg/kg) of chemical constituents deposited through aerosols and dust on the surface. Elemental assay of suspended and settled dust presented the profile into four groups. Elevated concentrations were detected for the core elements of dust like: Si, Fe, Al, Ca, Zr, K and Mn. Other elements are absorbed because of anthropogenic activities such as Zn, Ti, S, P and Ba are reflected as traffic pollutants which are incorporated in atmosphere through the wear and tear of tires and brakes, vehicular emissions and automotive refinishing activities etc.: W (626.7), Pb (595.7), Cr (344.0), Sc (269.4), Cu (231.6), Sr (200.6), and Ni (162.8), exhibiting excess Al and Fe, entered in atmosphere via solid waste burning, vehicular smoke, fossil fuel, coal combustion, and industrial emissions. High values of Na and Cl indicate south Asian dust particles were nucleated and coalesced from sea-salt spray during long-range transport. Source apportionment was supported by analyzing the data set using statistical and mathematical models like percent composition, comparative analysis, enrichment factor (EF), correlation coefficients and factor analysis (FA). Geo-spatial distribution of analytes was performed by applying GIS as a tool to map the results over the study area for identification of hotspots.

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7SA.5

Overview of the CARB High-Resolution Advanced Monitoring Program (CHAMP): An Expanded Monitoring Network to Address California's Air Quality Problems. CHINMOY SARKAR, Alison Fankhauser, Morteza Amini, Christopher Niedek, Nga Lee Ng, Qi Zhang, Michael FitzGibbon, *Research Division, California Air Resources Board*

To address regulatory challenges and support efforts to attain the annual PM2.5 standard in California, CARB is significantly expanding its monitoring capability through the CARB High-resolution Advanced Monitoring Program (CHAMP). This program involves deploying a statewide instrument network of eight Aerosol Chemical Speciation Monitors (ACSM), each equipped with a PM2.5 lens and capture vaporizer, to generate continuous, high-time-resolution measurements of PM2.5 chemical composition, including concentrations of organic aerosols (OA), nitrate (NO3), sulfate (SO4), ammonium (NH4), and chloride (Chl). ACSMs are co-located with Scanning Mobility Particle Sizers (SMPS) and black carbon analyzers (AE33/AE36) to enable comprehensive characterization of PM2.5 at each site. In addition to deploying and operating ACSMs and co-located instruments, CARB will focus on capacity building within the agency through training in instrument operation, data processing, and analysis. This will include, but not be limited to, developing Standard Operating Procedures (SOPs) and QA/QC protocols to support long-term sustainability of the network. We will present an overview of the CHAMP network and selected preliminary results from the acquired datasets. In the long run, CHAMP data will be used to conduct source apportionment using the Positive Matrix Factorization (PMF) model to identify and quantify major PM2.5 sources. When applicable, results will be compared with data from the Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT). These analyses will help assess regional and statewide PM2.5 trends, inform CARB's emission inventory, and guide air quality modeling for State Implementation Plans (SIPs) to develop targeted mitigation strategies.

7SA.6

Air Quality Dilemma in Karachi: Composition, Sources and Health Implications for Urban Centers. Muhammad Kamran Khan, Saiyada Shadiah Masood, Sumayya Saied, HAIDER KHWAJA, *Textile Institute of Pakistan*

Airborne particulate matter contamination remains a persistent environmental and public health concern across Asia, particularly in the megacities of developing nations. Numerous studies conducted in various urban centers across the continent have consistently reported elevated concentrations of particulate matter. In the present study, an extensive assessment of $PM_{2.5}$ was carried out in Karachi, Pakistan, to determine its mass concentration, chemical characterization, and source apportionment. Risk assessment was performed owing to high $PM_{2.5}$ levels, and the estimated number of deaths attributable to air pollution.

Throughout the study period, concentrations of fine particulates exceeded both the World Health Organization (WHO) guidelines and the National Environmental Quality Standards (NEQS) of Pakistan indicating the severe degradation of ambient air quality. Source apportionment using mass reconstruction, factor analysis, and enrichment factor techniques revealed that both natural and anthropogenic sources contribute significantly to particulate pollution. Major contributors include soil re-suspension, industrial emissions, fossil-fuel combustion, marine aerosols, and vehicular exhausts. Backward air-mass trajectory analysis demonstrated that fine particulates are transported from local, regional, and distant sources, further influencing the city's air composition. However, anthropogenic sources were found to dominate, primarily from industrial activities, fossil-fuel burning, and transport emissions. Risk assessment indicated a strong link between prolonged exposure to elevated $PM_{2.5}$ concentrations and increased morbidity and mortality. Though further studies are need of the hour, this study provides a comprehensive understanding of fine particulate pollution and associated pollutants, seasonal variations, and its health implications, with comparisons made between industrial and residential sites in Karachi.

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7TA.1

The Critical Role of Ammonia in the Aqueous-Phase Transformation of Hydroxymethyl Hydroperoxide on Deliquesced Aerosol Particles. YULU JIA, Zhongming Chen, *Peking University*

Ammonia (NH_3) is one of the most abundant alkaline gases in the atmosphere, and the ammonium salts (NH_4^+) formed from NH_3 are major inorganic components of aerosols. NH_3/NH_4^+ can not only alter reaction conditions by regulating acidity and ionic strength, but can also directly participate in aerosol chemistry as nucleophilic species. However, their effects on the aqueous-phase transformations of organic compounds remain poorly understood. Organic peroxides (POs) are important atmospheric intermediates and radical reservoirs, and their aqueous-phase transformations play a critical role in aerosol formation, aging, and associated environmental and health effects. Previous studies have largely focused on dilute solutions and therefore fail to capture the high ionic strength and multicomponent nature of aerosol liquid water. In this study, hydroxymethyl hydroperoxide (HMHP), a representative small PO, was selected as a model compound to investigate the effects of NH_3/NH_4^+ on its hydrolysis kinetics. The results show that, in the absence of ammonium salts, increasing ionic strength does not alter the reaction pathway of HMHP and only enhances its hydrolysis rate by approximately a factor of two. In contrast, in highly concentrated ammonium salt solutions, the hydrolysis pathway of HMHP is markedly suppressed, substantially decreasing the yields of hydrolysis products H_2O_2 and HCHO, while a previously unrecognized reaction pathway emerges and increases the apparent transformation rate of HMHP by more than an order of magnitude. Further investigation demonstrates that the new pathway is governed by NH_3 rather than NH_4^+. This study emphasizes that, compared with the limited effects of ionic strength, the specific reaction pathways introduced by NH_3 can significantly alter peroxide lifetimes and radical budgets. Therefore, the chemical role of NH_3 should be explicitly considered when evaluating the contributions of POs to atmospheric oxidation capacity and secondary aerosol formation.

7TA.2 – INVITED

Surface-Sensitive Mass Spectrometry – An Approach to Examining Particle Oxidation and Particle Growth. LISA WINGEN, Zachary Schiffman, Elizabeth Wingen, Yuekin Yang, Michelia Dam, Yiming Qin, James Smith, Barbara Finlayson-Pitts, *University of California, Irvine*

Airborne particles have significant impacts on human health, visibility, and climate. Particles can have a highly viscous phase, resulting in slow internal mixing that may cause the surface composition to be different than the bulk. Heterogeneous chemistry, particle growth, and water uptake will be governed by the surface composition which is determined by the interaction of gases with the surface. However, measuring the surface composition presents challenges due to the small amount of material present relative to the bulk. Matrix Assisted Ionization in Vacuum-Mass Spectrometry (MAIV-MS) is a surface-sensitive method that detects species on the surface of solid glutaric acid particles (GA), shown to be an efficient ionization matrix. MAIV-MS studies of the oxidation of GA particles by OH under a range of gas-phase RO_2 and HO_2 concentrations provide insight into the impact of gas-phase radicals on the products formed at the surface. The stable alcohol and ketone formed in the GA oxidation are detected, along with labile peroxides. These experiments show that the fate of surface-bound RO_2 radicals is highly dependent on the gas-phase radicals present.

MAIV-MS has also been used to investigate particle growth via the condensation of highly oxygenated products formed from OH-oxidation of ethylbenzene. GA particles serve as both the ionization matrix and as a condensation surface for oxygenated products, minimizing wall losses of these products. Oxidation products consistent with the formation of peroxides from several formation pathways were detected, indicating that they were scavenged from the gas phase. Accretion products were observed from several formation pathways, including multiple OH attacks on the aromatic ring as well as contributions from RO_2 isomerization. The use of MAIV-MS for condensable product detection provides direct insight into low volatility species that can form and grow particles, leading to a more comprehensive picture of secondary organic aerosol formation and growth.

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7TA.3

Phase States Shape the Size-Dependent Hygroscopicity of Organic–Water Nanoclusters. JIAQI WEN, Xiaohan Li, Ian Bourg, *Princeton University*

The κ-Köhler framework assumes ideal mixing and a single well-defined interface, yet whether these assumptions hold for nanometer-scale aerosol clusters remains unclear. Here, we use a computational chemistry approach, molecular dynamics (MD) simulations, to quantify the hygroscopic behavior of ten representative organic–water binary nanoclusters, including dicarboxylic acids, organosulfates, and oxidation products of α-pinene and isoprene, under both sub-saturated and supersaturated conditions.

Bulk κ values predicted by MD simulation for these organic species agree well with macroscopic measurements, which validates our simulation approach. Our simulations reveal that, at the nanoscale, water uptake becomes strongly dependent on cluster size, with deviations governed by cluster morphology (i.e., spatial configurations and phase-separation states of organic and water molecules within the clusters). Cluster morphology, in turn, is sensitive to by ambient relative humidity (RH) and the intrinsic physicochemical properties of the organic species. In particular, phase-separated clusters that adopt a core–shell geometry develop multiple interfaces, causing their hygroscopic growth to deviate markedly from predictions of the Kelvin equation.

Our findings demonstrate that approaches based on extrapolating bulk κ values to the nanoscale using a Kelvin correction can produce significant errors in clusters smaller than about 4 nm. For clusters with complex morphologies and multiple interfaces, size corrections informed by the molecular-level phase state are needed to accurately assess the hygroscopic growth of newly formed particles.

7TA.4

Exploring the Connection Between Aerosol Particle Properties and Reactivity. STEPHANIE SALAS, Craig Sheldon, Kyle McMillan, Aaron M. Palmisano, Teresa Palacios Diaz, Katie Morton, Anika Patel, Ryan Davis, James F. Davies, *University of California, Riverside*

Aerosol particles act as microreactors whose physicochemical properties strongly influence their reactivity. Depending on their composition, these particles can exist in a range of phase states that directly impact their reactivity. In the atmosphere, highly viscous phases have been shown to significantly slow heterogeneous oxidation by limiting the diffusion of oxidants and the transport of reactants and products within the particle. Recently, the formation of gel states in particles containing a mix of organic molecules and salts have been identified. In contrast, aerosols can experience accelerated chemistry, with reaction rates in microdroplets reported to increase by factors of ~10^2 to 10^6 when compared to bulk solutions. In this work, we present an experimental platform to probe the composition of levitated aerosol particles and compare the reactivity of viscous and gel particles towards ozone, as well as accelerated kinetics in condensation and esterification reactions. We use a linear quadrupole electrodynamic balance (LQ-EDB) to levitate individual particles and Mie resonance spectroscopy to determine the size and refractive index. Particles are ejected individually from the LQ-EDB to an open port sampling interface (OPSI) and aspirated into the electrospray ionization source to be sampled by an Orbitrap Q Exactive mass spectrometer to characterize the evolving chemical composition. Our results demonstrate that the reaction rate of viscous particles becomes slowed, while the reaction rate in gel particles becomes fully arrested after an initial period of rapid reaction. Preliminary results on accelerated chemistry further demonstrate that aerosol droplets can promote reactions that are otherwise unfavorable in bulk solutions. Together, these findings highlight the critical role of aerosol particle properties in governing atmospheric reactivity and chemical transformations.

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7TA.5

Spontaneous Oxidation of Nitrous Acid at Atmospherically Relevant Concentrations on Aerosol Interfaces and Its Feedbacks Between Uptake Kinetics and Acidity. GRAHAM THORNHILL, Luke Monroe, Jack Hall, Ryan Sullivan, *Carnegie Mellon University*

Nitrous acid (HONO) is an important member of the nitrogen oxide chemical family that control tropospheric ozone production. HONO is primarily present at night in polluted atmosphere due to its rapid photolysis rate but can still be present at lower concentrations during the day. Chemical models still struggle to account for atmospheric HONO observations, with much attention placed on discovering new chemical sources of HONO. Aerosol uptake has previously not been considered a major sink for HONO due to weak acidity (pKa ~3.2) being higher than the pH of acidic fine aerosol, preventing deprotonation and keeping HONO in a more volatile form. Our recent work demonstrated the spontaneous oxidation of HONO to HNO3 in droplets of initial pH between 0 and 7.75. This oxidation was accelerated in acidic droplets (pH < 2) and in unbuffered droplets compared to buffered droplets that resist acidification. We attributed this to HONO remaining at the air-water interface allowing for the formation of a HONO dimer that reacts with O2, producing HNO3. Aerosol optical tweezers enabled this new discovery given the ability to distinguish between nitrite and nitrate in the cavity-enhanced Raman spectrum acquired from the droplet in real-time. This spontaneous oxidation of HONO to HNO3 followed a second-order rate dependence on the HONO concentration, from experiments conducted at high HONO concentrations down to the low ppm range. We present new kinetic data probing tropospheric HONO concentrations of 10–50 ppbV using our custom aerosol optical tweezers system. Despite the second-order dependence on HONO, the spontaneous oxidation rate is still appreciable under low ppb HONO conditions. The effect of initial and evolving droplet composition, pH, and buffering capacity on the kinetics of HONO uptake and reactivity was also explored at these lower HONO concentrations.

7WF.1

Understanding Spatial Variations in Non-Refractory PM1 Compositions from the Los Angeles Wildland Urban Interface (WUI) Fires. COLETTE SCHISSEL, Albert Kyi, Chun-Ying Chao, Katarina Konon, Shihao Zhai, Chou-Hsien Lin, Evelyn Deveraux, Anna Neville, Daniel H. Sung, Lea El Khoury, Pawel K. Misztal, David T. Allen, Lea Hildebrandt Ruiz, *The University of Texas at Austin*

The Eaton and Palisades wildfires, which occurred at the wildland urban interface in Los Angeles county in January 2025, burned a complex mixture of fuels including residential structures, commercial buildings, vehicles, and biomass. The burning of natural and anthropogenic materials impacts the emissions associated with WUI fires. The potentially toxic emissions from the combustion of non-natural materials, combined with the proximity to human populations, makes understanding the health impacts of WUI fires a priority. This work presents findings from vehicle-based measurement campaigns that occurred in February and May of 2025 in the regions affected by the Eaton and Palisades fires. More specifically, this work characterizes non-refractory submicron aerosols (PM_1) that persist in WUI regions after the fire has been fully contained. The distribution of PM_1 compositions is compared with spatially and temporally resolved fuel loading, estimated chemical characteristics of the fuels and emission inventories. The comparisons are used to explain spatial variations in PM_1 composition fractions and to propose sources of emissions that are not commonly found in wildfire regions and are unique to WUI fires.

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7WF.2

Aerosol Exposures During Debris Cleanup After a Major WUI Fire. Tong Zhang, Sunny Kant, Colette Schissel, David T. Allen, MICHAEL KLEEMAN, *University of California, Davis*

The wildfires that burned into the cities of Altadena and Pacific Palisades in January 2025 exposed nearly 18M nearby residents in Los Angeles to airborne particles containing a unique mixture of toxic substances. More than 16,000 buildings were burned along with many vehicles, injecting a wide range of metals and partially burned plastic compounds into the atmosphere. The active fires were extinguished within a week but exposure to aerosols generated by debris removal continued for months afterwards. Approximately 100,000 dump truck loads of debris were removed from burn sites, sorted at nearby stations, and then taken to disposal sites over a cleanup period of ~8 months. Ambient monitoring around debris removal sites detected the presence of oxidized metals including hexavalent chromium (Cr6+). Here we combine ambient measurements with chemical transport models (CTMs) to estimate exposures during debris cleanup in support of future health impact studies. A spatially resolved emission estimation method is developed for debris removal sites and a road network routing analysis is used to estimate emissions from debris hauling activities. Emissions from cleaning activity and heavy-duty dump trucks are quantified and mapped to regional air quality model grids. CTM calculations are used to quantify population exposure in the greater Los Angeles area. This case study represents an increasingly common disaster scenario when wildfires burn into major cities. Therefore, better characterization of exposure during the active fire and during the cleanup phase is important for future wildfire emergency management, exposure assessment, and public health protection.

7WF.3

Modeling Smoke Toxicity in WUI Fires with QUIC-Fire. ALEXANDER JOSEPHSON, Isabella Martinez-Pruet, Matthew Nelson, Sara Brambilla, *Los Alamos National Laboratory*

This presentation shares the latest model developments in QUIC-Fire to capture the wide range of smoke toxins coming from WUI fires. We share the past development, validation, and gaps in the particulate matter model along the with the driving physics of the processes this model is representing. We share the current developments, validation, and gaps for the emitted gas species and the statistical methods used to expand the profile speciation from a few key species of interest to a larger set of species of interest, including VOCs which continue to interact with particles post-emission. We share the current developments and advancements of modeling the emission of none-carbon high-toxicity species -- primarily halogens and metals -- including a series of proposed mechanisms that split the emission of these species between particle, gas, and char phases. Lastly, we share the connection of these emitted profiles to the toxicity correlations to show impacted areas in and around WUI fires.

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7WF.4

Airborne Lead Nanoparticles from Smoke and Dust After the Los Angeles Fire. ALIREZA NAMAYANDEH, Charles Lamb, Frida Garcia-Ledezma, Catherine Erol, Dan Kubota, Raphael Kim, Jonathon Howell, Charise Young, Scott Fendorf, *Stanford University*

The 2025 wildland–urban interface (WUI) fires in Los Angeles generated large quantities of particulate matter that contaminated the atmosphere as well as the ash and debris remaining after the fires. Among these emissions, ultrafine (>0.25 μm) lead (Pb) particles are of particular concern because of their ability to penetrate deep into the respiratory system, enter circulation, and potentially cross the blood–brain barrier. Despite these risks, the formation and distribution of Pb nanoparticles during WUI fires remain poorly understood. To characterize the full size range of smoke particles, we collected air samples directly from the Eaton fire plume using active air samplers equipped with cascade impactors that separated particles from coarse fractions (>2.5 μm) to ultrafine fractions (<0.25 μm). Although Pb is not typically considered a dominant component of wildfire smoke, measured concentrations reached 0.45 μg m^{-3}, approximately three times higher than the U.S. EPA air quality standard of 0.15 μg m^{-3} (3-month average). More than 80% of smoke-associated Pb was found in ultrafine particles. We further investigated the potential for post-fire redistribution of ultrafine Pb particles from burned residential materials. Ash and debris collected from destroyed homes in Los Angeles were resuspended in a custom-designed windbox under gentle wind conditions (8–12 mph). Up to 20% of the resuspended particles were within the ultrafine size range (<0.25 μm), and Pb was detected across multiple particle-size fractions, including the ultrafine fraction. Together, these findings show that the smallest particles produced during and after WUI fires can carry substantial toxic metal burdens. The results highlight the need for air quality monitoring and public health frameworks to account not only for PM2.5 mass, but also for the abundance and composition of ultrafine metal-bearing particles.

7WF.5

Near-Real-Time Monitoring of Particulate Metals Across the South Coast Air Basin: Insights Into Extreme Air Quality Events. PROVAT SAHA, Christopher Lim, Steven Boddeker, Julia Montoya-Aguilera, Zihan Zhu, Joseph Salazar, Yumeng Cui, Mohammad Sowlat, Payam Pakbin, Stephen Dutz, Jason Low, *South Coast Air Quality Management District*

With recent advances in online monitoring technologies, such as X-ray fluorescence (XRF)-based ambient metal monitors, real-time measurement of particulate metals is emerging. South Coast Air Quality Management District (South Coast AQMD) initiated continuous metals monitoring about a decade ago, beginning with two sites in the City of Paramount, and has since expanded the continuous metals monitoring across the South Coast Air Basin (SCAB) as part of multiple special air monitoring studies.

While continuous metals monitoring data are valuable for tracking spatiotemporal variability and long-term trends in particulate metals, they also offer superior capability compared to traditional time-integrated monitoring methods for capturing the magnitude and rapid evolution of air toxic metals during extreme and episodic events, such as wildfires and fireworks. For example, data from this network was valuable for assessing trends, chemical composition, and sources of particulate metals during the recent 2025 urban wildfires in Los Angeles. In addition, these data have also allowed for characterization of ambient particulate metals during Independence Day fireworks, indicating not only elevated concentrations of several metals during this event, but also chemical signatures that are generally distinct from those of wildfires.

In this presentation, continuous multi-metal monitoring data from multiple special studies and programs are used to evaluate trends and chemical signatures of particulate metals during different extreme air quality events, including urban wildfires, non-urban wildfires, and Independence Day fireworks. The presentation highlights the chemical signatures of particulate metals during these events, examines how they vary across event types, and compares them with typical ambient conditions.

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7WF.6

Characterizing Postfire Concentrations and Elemental Speciation of Ambient PM2.5 and PM10 Samples Within the Eaton and Palisades Fire Burn Zones. KY TANNER, Kevin Ridgway, Haoxuan Chen, Yifang Zhu, Christian L'Orange, Shantanu Jathar, *Colorado State University*

In the last few decades an estimated ~50 million new homes have been built along the wildland-urban interface (WUI). As the WUI continues expanding, structural fires are becoming an increasingly relevant source for wildfire emissions. Recent studies have shown structural fire smoke to be chemically distinct from, and more hazardous than, wildland fire smoke. However, less attention has been given to the lingering impact these fires have on the air quality, in the months and years following the fires' extinction. In this study, we collected 32 ~1-week samples of $PM_{2.5}$ and PM_{10} from 20 distinct locations within the burn zones of the Palisades and Eaton fires, in the 1st, 3rd, and 6th months following fire extinction. We found slightly lower median PM concentrations in our burned zone samples when compared with a reference monitor at a central Los Angeles EPA site, for the same time period (5.0 vs 9.1 $\mu g/m^3$ for $PM_{2.5}$ and 16.4 vs 21.5 $\mu g/m^3$ for PM_{10}). However, when examining the elemental speciation of the burned zone samples we found several toxic metals, associated with structural fires, in concentrations much higher than those at the EPA's Central LA site. The median Pb and Cd $PM_{2.5}$ concentrations, presumably associated with resuspended automobile and lead paint ash, in our post-fire samples were ~7X higher than Central LA site samples (Pb: 14.4 vs 2.0 ng/m^3; Cd: 18.6 vs 2.6 ng/m^3). When accounting for the overall lower PM concentrations in our burned area samples (normalizing to total filter mass) the median mass fractions become ~15X and 29X greater than those of the median EPA samples mass factions, for Pb and Cd respectively. These findings provide evidence that even without active fires burning, post-fire burned zones in WUI regions can still provide heightened exposures to many toxic chemicals.

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8AC.1

Chemical Characterization of Secondary Organic Aerosol Formed from the Hydroxyl Radical Initiated Oxidation of Volatile Organic Compounds Derived from Cyanobacterial Harmful Algal Blooms. SAMANTHA BELL, Mia Kauffman, Cara Waters, Andrew P. Ault, Jason Surratt, *University of North Carolina at Chapel Hill*

Secondary organic aerosol (SOA) contributes substantial mass fractions to PM2.5, yet the detailed atmospheric chemical pathways for SOA formation from volatile organic compounds (VOCs) released from cyanobacterial harmful algal blooms (cHABs) are severely understudied. VOCs, including geosmin, 2-methylisoborneol, β-ionone, and β-cyclocitral, are emitted from cHABs and have the potential to undergo atmospheric oxidation to form PM2.5. Preliminary work demonstrated the ability for geosmin, 2-MIB, and β-cyclocitral to undergo nucleation to form SOA, yet SOA from condensational growth and multiphase chemical pathways on preexisting inorganic aerosols also needs to be examined. A smog chamber was used to oxidize the VOCs in the presence of acidic sulfate aerosol to explore the condensation or multiphase chemistry of cHAB-derived VOC oxidation products. A Scanning Electrical Mobility Sizer (SEMS, Brechtel Inc.) measured real-time aerosol size distributions. SOA particles were collected onto Teflon filters, extracted, and analyzed using reversed-phase liquid chromatography, coupled to a high-resolution tandem mass spectrometer equipped with an electrospray ionization source (RPLC-ESI-HR-QTOFMS/MS). The gas-phase composition was monitored by a real-time chemical ionization mass spectrometer (CIMS) to time-resolve the oxidation products as the atmospheric oxidation progressed. The gas-phase and SOA chemical composition data were used to characterize mechanistic pathways (i.e., both gas-phase oxidation and particle-phase chemical reactions) of SOA formation. To connect to real-world cHABs, studies were conducted at Grand Lake Saint Mary's (GLSM), a large, shallow lake in north-western Ohio plagued by cHABs. Quartz fiber filters were collected using a high-volume PM2.5 sampler and sent to the University of North Carolina at Chapel Hill for extraction and RPLC-ESI-HR-QTOFMS/MS analysis. We use the field data to determine if laboratory-generated SOA compounds are identified in the airshed of GLSM.

8AC.2

From the Chamber to the Atmosphere: Understanding the Influence of RO_2 Fate Distributions on Secondary Organic Aerosol Composition Through Chamber-Ambient Comparisons. ELINOR CABALLERO, Nadia Tahsini, Matthew Goss, Lesly Franco Deloya, Erik Helstrom, Jesse Kroll, Weiwei Hu, Jose-Luis Jimenez, Manjula Canagaratna, Hannah Kenagy, *University of Minnesota*

The abundance and composition of atmospheric secondary organic aerosol (SOA) is influenced by the fates of organic peroxy radicals (RO_2), key intermediates in the oxidation of volatile organic compounds (VOCs). Laboratory studies of SOA formation have historically been conducted under low- and high-NO_x extremes, where $RO_2 + HO_2$ and $RO_2 + NO$ reactions dominate, respectively. Such conditions can suppress additional RO_2 fates, such as $RO_2 + RO_2$ and RO_2 isomerization reactions.

Here, we evaluate the compositional similarity of SOA from chamber studies of isoprene and α-pinene with varied RO_2 fates to ambient observations from the Southern Oxidant and Aerosol Study (SOAS). These experiments were designed using a model-informed approach intended to achieve a broader distribution of RO_2 fates, with particular emphasis on promoting RO_2 isomerization. Using the cosine similarity metric, we quantify compositional similarity between chamber and ambient Aerosol Mass Spectrometer (AMS) measurements, demonstrating that chamber experiments that better approximate ambient RO_2 fate distributions yield spectra that are more consistent with ambient observations than SOA from experiments with NO_x-extreme conditions.

From these chamber experiments, we also identify candidate AMS marker ions associated with specific RO_2 fates, and we evaluate their robustness by comparing their spatiotemporal variability in ambient AMS data with the variability of known RO_2 fate markers in co-located chemical ionization mass spectrometer (CIMS) measurements. This work highlights laboratory-field comparisons as a useful framework for translating insights from controlled experiments into a better understanding of field measurements.

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8AC.3

Quantifying the Spatial Heterogeneity of Biogenic Emissions at Kilometer-Level Distance Scales Using a Tropical Ecosystem as a Case Study. SHALLON MUTSA JOZI, Jacob Hayes, Chloe Chee-Zefi, Maya Huang, Jordan Karubian, Leighton Reid, Gabriel Isaacman-VanWertz, *Virginia Tech*

Biogenic volatile organic compounds (BVOCs) constitute the largest global source of organic carbon emissions to the atmosphere and their major classes, isoprene, monoterpenes, sesquiterpenes, and oxygenated VOCs are key drivers of the atmospheric chemistry that produces ozone and secondary organic aerosols. This study examines the spatial distribution of biogenic reactive organic carbon across a tropical forest landscape in Ecuador by quantifying monoterpenes, sesquiterpenes, and oxygenated VOCs. Monoterpene and sesquiterpene emissions show strong fine scale heterogeneity across landscapes, yet atmospheric models typically treat these compounds as spatially uniform. Current emissions models will be shown to exhibit little diversity in composition between grid cells, suggesting chemical transport models are implicitly assuming relative spatial homogeneity of the dominant classes of reactive organic carbon. We examine this assumption at a local scale through samples collected by active and passive sorbent sampling at more than 50 sites across several square kilometers in a tropical high-altitude forest in Ecuador. Sample collection was co-located with detailed surveys of vegetation composition, wild fruit availability, and other ecosystem characteristics. We evaluate how physical and ecological factors influence terpene composition by assessing the similarity between sesquiterpene and monoterpene distributions and identifying the drivers of both their similarities and differences across environments. Neither the quantity nor composition of isomers within different terpene classes were observed to be correlated with distance between samples, with terpene composition instead correlated in some cases with wild fruit availability and ecosystem features. By examining correlations of spatially average samples, we will consider the implications of these results for larger-scale heterogeneity and what current assumptions used in atmospheric models might be impacting aerosol formation and chemistry.

8AC.4

Organic Synthesis, Isomer-Resolved Mass Spectrometry, and Computational Chemistry in the Study of Pinene Secondary Organic Aerosol. CHRISTOPHER KENSETH, Olivia Hakan, Donterrio Moore, Yuzhi Chen, Vili-Taneli Salo, Matthieu Riva, Michael Kamrath, John Shilling, Henrik Kjaergaard, Joel Thornton, *University of Washington*

The ozonolysis of α-pinene and β-pinene ($C_{10}H_{16}$) represent dominant global sources of atmospheric secondary organic aerosol (SOA) and are canonical SOA systems. Despite this importance and decades of study, many of the chemical processes underlying the formation and evolution of pinene SOA remain poorly understood. Here, we highlight recent molecular-level insights into the formation of pinene SOA enabled by combining organic synthesis, isomer-resolved mass spectrometry, and computational chemistry. These studies demonstrate that integration of these typically separate research tools can open previously inaccessible frontiers of atmospheric aerosol chemistry by affording unambiguous identification and quantification of individual compounds in SOA and facilitating elucidation of their formation mechanisms.

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8AC.5

Terpene Structure Governs Humidity-Enhanced New Particle Formation Through An OH-Sensitive Ozonolysis Network.

TIJESUNI ADEOYE, Giuseppe Petrucci, *University of Vermont*

Relative humidity (RH) impacts new particle formation (NPF) from monoterpene ozonolysis in a non-uniform way. Depending on the precursor, water vapor can either suppress particle formation or increase it, and the chemical origin of that contrast has remained uncertain. Here we use cyclohexane to remove OH and separate the OH-sensitive portion of the particle response from the residual OH-insensitive contribution for α-pinene, β-pinene, and camphene. Experiments were carried out at <0.1% and 60% RH using low monoterpene mixing ratios of 0.5 – 5 ppbv. In the absence of scavenger, the maximum number of particles formed (N_{max}) increased strongly with RH for α-pinene and β-pinene (Enhancement Factor, ΔN_{max} = 1.06 and 0.76) but not for camphene. Once OH was scavenged, the humid experiments no longer produced higher N_{max} than the corresponding dry experiments. The dry-condition OH-sensitive fractions were 87.5% for α-pinene, 79.9% for β-pinene, and 53.7% for camphene. We then compared these results with literature ozonolysis OH-forming yields for a broader five-terpene set that also includes α-terpinene and γ-terpinene. The comparison shows a useful but limited role for OH yield: compounds with very low OH-forming propensity show little RH enhancement, yet the magnitude of the enhancement is not set by OH yield alone. α-Terpinene, for example, gives the largest response despite an intermediate OH yield, whereas γ-terpinene has a much higher OH yield but a smaller enhancement. We therefore place the RH effect within a structure-dependent OH-sensitive ozonolysis network in which Criegee Intermediate (CI) geometry, radical fate, autoxidation, and precursor concentration all influence whether additional water vapor ultimately produces more new particles.

8AC.6

Molecularly Resolved Fenton-like Reactivity of Organic Peroxides in Monoterpene-Derived Secondary Organic Aerosol.

YUE ZHAO, Fengfeng Dong, Chongxuan Chang, *Shanghai Jiao Tong University*

Organic peroxides are key reactive intermediates formed during the atmospheric oxidation of organic compounds. They play a central role in the formation and evolution of secondary organic aerosol (SOA) and significantly influence aerosol health effects. The reactions of organic peroxides with transition metal ions (TMIs), a ubiquitous component of atmospheric aerosol, are recognized as one of the most important atmospheric fates of these reactive species. However, current understanding of the Fenton-like reactivity of structurally diverse and abundant peroxides present in SOA remains limited. This knowledge gap poses a substantial challenge to accurately assessing the contribution of Fenton-like reactions to the fate of organic peroxides and the chemical evolution of SOA in the atmosphere. In this study, we combined high-resolution mass spectrometry (LC-MS and LC-MS^2) with a series of scavenging experiments to identify the molecular composition and structure of a broad suite of organic peroxides in α-pinene-derived SOA. We further quantified their Fe(II)-mediated Fenton-like reactivity in the aqueous phase, elucidated the dependence on peroxide composition and structure, and characterized the associated product formation and evolution of SOA composition. By integrating these kinetic and mechanistic information, we evaluated the relative importance of Fenton-like reactions in controlling the fate of monoterpene-derived organic peroxides and the chemical aging of SOA under typical atmospheric conditions.

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8AC.7

Separating Isomers and Identifying Molecular Structures in Organic Aerosol by Combined Thermal Desorption Chemical Ionization Ion Mobility and Mass Spectrometry. SIEGFRIED SCHOBESBERGER, Madison Rutherford, Qing Ye, Christopher Kenseth, Brett Palm, Andre Schaum, Jia Jiang, Douglas A. Day, Anne V. Handschy, Jose-Luis Jimenez, Joost A. de Gouw, *University of Eastern Finland*

Chemical ionization mass spectrometers (CIMS) are a powerful tool for identifying and quantifying organic trace gas species in the atmosphere. When coupled with an inlet setup for aerosol thermal desorption, we can investigate also the composition of organic aerosol (OA) particles at a molecular level. A weakness of CIMS is that it can only measure elemental formulas, whereas molecular structural information remains elusive. However, even in laboratory experiments involving a single aerosol precursor vapor, most molecular formulas of OA constituents are compatible with multiple feasible structures that can vary widely in their physical and chemical properties.

In this study, we used a CIMS using iodide anion reagents. Immediately after the ion-molecule reactor, a traveling-wave ion mobility spectrometry (IMS) module separates the analyte-reagent adducts by their drift time in a helium buffer gas, followed by detection in a time-of-flight mass spectrometer. For each elemental formula identified in the mass spectrum, the IMS enables additional separation of isomers, as they typically differ by drift time. We coupled this instrument with a filter inlet for gases and aerosols (FIGAERO). The FIGAERO allows semi-online measurements of both gas- and aerosol particle-phase composition and can elucidate molecular volatilities from gas/particle partitioning ratios and thermal desorption behaviors.

We characterized this system using test aerosols and synthesized standards corresponding to pinene oxidation products. We then investigated OA produced from monoterpene oxidation in a chamber, simulating oxidation conditions of an urban night-time atmosphere. Most detected oxygenated organic formulas indeed corresponded to multiple isomers, and isomeric separation proved extremely helpful or even crucial for obtaining accurate gas/particle partitioning ratios and thermal desorption profiles. We also applied a newly developed procedure for obtaining theoretical drift times of the ion adducts of candidate species, based on quantum chemical calculations and instrument calibration. The combined approach allowed us to assign likely molecular structures to OA constituents, from products of gas-phase terpene processing to particle-phase accretion products.

8AD.1 – INVITED

Smoke, Dust, and Resilience: Unraveling the March 2025 Oklahoma Compound Hazards. SANDRA MARCELA LORIA SALAZAR, Connor Flynn, Hayden Webb, Emily West, Jeffrey Lee, Cameron Homeyer, Stacey Hitchcock, *University of Oklahoma, School of Meteorology*

On March 14, 2025, an intense low-pressure system over the Southwest U.S. collided with humid air masses, triggering a severe weather outbreak across multiple states. Texas and Oklahoma were hit particularly hard, experiencing destructive winds up to 85 mph, widespread dust storms, and rapidly advancing wildfires. Satellite imagery captured extensive dust plumes and smoke emissions, especially near wildfire zones in Oklahoma. The extreme conditions led to over 170,000 acres burned, more than 400 structures damaged or destroyed, widespread power outages, and multiple fatalities, prompting a state of emergency.

This study examines the intricate relationships between meteorological drivers and aerosol behavior during this multi-hazard event. Leveraging a suite of satellite and ground-based remote sensing tools, in situ observations, back trajectory analyses, and meteorological reanalysis data, we assess how aerosol physical, optical, and chemical properties evolved throughout the event. We also examine the atmospheric conditions that facilitated long-range dust transport and the ignition of wildfires. Our findings provide critical insights into the growing threat of compound hazards in the Southern Great Plains and underscore the importance of integrated observational strategies for enhancing regional resilience and air quality management

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8AD.2

Iron-Driven Chlorine Activation in Mixed Dust–Sea Spray Atmospheric Particles Collected Aboard Research Aircraft over the Tropical Atlantic. TEMITOPE OLAYEMI, Steven Sharpe, Alexander Laskin, Julius Ese, Seth Koloski, Daniel Knopf, John Mak, Julia Marcontonio, Bingbing Wang, Jiao Xue, *Purdue University*

Chlorine atoms are an important but poorly constrained oxidant of atmospheric methane (CH_4). Their production via iron-chloride photochemistry in mineral dust-sea spray aerosols (MDSA) has been proposed as a significant regional methane sink over marine environments. In this mechanism, Fe(III) within acidified dust-salt particles undergoes ligand-to-metal charge-transfer photochemistry with chloride ions, producing Cl_2 that photolyzes to Cl in the gas phase, while Fe(II) is regenerated through Fenton-type chemistry. Despite modeling and ship-based evidence, particle-scale observational confirmation in the ambient atmosphere has been lacking.

The CHLOROX (Chlorine Oxidation Experiment, Atlantic Basin) project conducted 11 research flights over Barbados, and aerosol samples were collected using the Time-Resolved Aerosol Collector (TRAC) for single-particle analysis integrating computer-controlled scanning electron microscopy with energy-dispersive X-ray spectroscopy (CCSEM/EDX) and scanning transmission X-ray microscopy with near-edge X-ray absorption fine structure (STXM/NEXAFS) Fe L-edge spectromicroscopy, enabling characterization of particle composition, chloride depletion, and Fe(II)/Fe(III) speciation at sub-particle resolution.

Fe-sea salt particles were classified by degree of chloride depletion and sulfate content. Vertical profiling revealed that chloride-depleted, sulfate-free Fe-sea salt particles were enriched aloft within Saharan Air Layer-influenced layers, while unreacted particles dominated near the surface. STXM/NEXAFS measurements revealed Fe redox heterogeneity within individual mixed particles, with Fe(II)/Fe(III) microdomains coinciding spatially with chloride-depleted regions, providing the first direct particle-resolved evidence linking Fe redox cycling to halogen loss. An inverse relationship between Fe/Na and Cl/Na ratios across flights supports iron enrichment and chloride displacement as dynamically coupled processes.

These findings establish that the MDSA mechanism operates across the vertical extent of the tropical Atlantic beyond the marine boundary layer. Models relying on averaged aerosol composition likely underestimate the efficiency and spatial extent of chlorine-mediated methane oxidation, with implications for global methane budgets and iron-salt aerosol-based methane removal strategies.

8AD.3

Anthropogenic Dust Emissions Are Greatly Underestimated in the Contiguous U.S. HAIHUI ZHU, Jennifer McGinnis, Moumita Chanda, Alex Maas, Jude Bayham, James Crooks, *Department of Atmospheric Science, Colorado State University*

Dust emitted from anthropogenic activities contributes to ambient particulate matter (PM), which is associated with millions of premature deaths annually. This study leverages ground-based monitoring data across the contiguous United States (CONUS) and simulations from the GEOS-Chem chemical transport model to evaluate the uncertainties and potential biases in anthropogenic dust emissions provided by the National Emissions Inventory (NEI). Results indicate that coarse-mode PM concentrations are underestimated by GOES-Chem by about 46%, with a mean bias of -3.23 μg/m³ for the year 2019, whereas fine-mode PM estimates exhibit much better agreement, with a mean bias of +1.43 μg/m³. The GEOS-Chem underestimation of coarse PM persists throughout the year and is strongly correlated with population density, cropland, and fallow land distribution. Sensitivity tests conducted using GEOS-Chem suggest that discrepancies between observed and simulated PM concentrations are primarily driven by uncertainties in anthropogenic dust emissions rather than dry deposition or natural dust sources. Applying spatial regression to the sensitivity test results further reveal that biases are more pronounced for agricultural dust emissions, particularly in regions such as the East Coast and the Great Plains. A CONUS-wide mean bias factor of 7.37 was identified for agricultural dust emissions, compared to 1.66 for non-agricultural anthropogenic dust emissions. Future works on physical or statistical based approaches to improve anthropogenic dust emissions are desired for better model representation of surface coarse PM concentration.

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8AD.4

Desert-Urban SysTem IntegratEd AtmospherIc Monsoon (DUSTIEAIM): Overview and Findings from the First Summer. ALLISON AIKEN, Katherine Benedict, Sonia Kreidenweis, Lynn M. Russell, Daniel Feldman, DUSTIEAIM Science and Operations Teams, *Los Alamos National Laboratory*

The Desert-Urban System Integrated Atmospheric Monsoon (DUSTIEAIM) campaign is a 16-month U.S. Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) User Facility field campaign focused on energy and water challenges in one of America's fastest-growing and most heat-stressed urban regions: Phoenix, Arizona. DUSTIEAIM has three interrelated science objectives focused on Land-Atmosphere Interactions and Impacts, Aerosol Processes and Interactions with Clouds and Radiation, and Precipitation Processes and includes an interdisciplinary science team composed of national laboratories, universities, and agencies with a broad range of subject-matter expertise. DUSTIEAIM data collection began in June 2026 to capture the North American Monsoon (NAM) and to characterize interactions between the land surface and the atmosphere over a desert megalopolis (Phoenix). DUSTIEAIM interrogates the interaction between precipitation events, storms, and aerosol in the context of spatial contrasts at the urban interface with agricultural and drylands in the Sonoran Desert. The goal is to redefine how we model urban-land-atmosphere interactions, monsoon storms, and aerosol-cloud interactions.

Some of the first results from the first Intensive Operational Period (IOP) occurring during the monsoon season from July – September 2026 will be presented that focus on radiative properties, aerosol interactions, cloud formation, and precipitation in Arizona. Synoptic and mesoscale/convective dust events and storms (haboobs) will be the focus of our presentation. Aerosol observations include highlights from the data collected from the ground-based Aerosol Observing System (AOS) as well as vertical profiles from the Tethered Balloon Sonde (TBS) for aerosol process studies and interactions with clouds and radiation. Results from the scanning radar and radiosondes will be included for major precipitation and convective events.

In summary, we will present some of the first results from DUSTIEAIM that include active and passive ground-based sensors, radars, and integrated modeling to deliver a comprehensive environmental data set at the desert-urban-agricultural interface for dust sources, sinks, and characteristics as sampled in Phoenix, Arizona to better understand their impacts in the Southwestern U.S.

8AD.5

Airborne Measurements of Local and Long-Range Transported Mineral Dust in the Arctic. XINGZHI CHEN, Logan Forshee, Andrew Holen, Vanessa Selimovic, Lauren Zamora, Kerri Pratt, *University of Michigan*

The Arctic is warming rapidly, related to feedbacks associated with the loss of sea ice, permafrost melt, and glacial ice retreat. While mineral dust has significant impacts on the radiative budget, there are limited measurements of mineral dust in the Arctic. Mineral dust can scatter and absorb radiation and act as ice nucleating particles and/or cloud condensation nuclei, affecting cloud microphysics, precipitation, and lifetime. Mineral dust in the Arctic atmosphere is often transported from lower latitudes, but increasing Arctic temperatures are exacerbating glacial ice decline and local emissions of mineral dust aerosols from exposed bedrock and soil. The impact of mineral dust on the Arctic radiative budget remains uncertain, partially due to limited knowledge of both local and transported aerosol sources. To address these uncertainties, the NASA Arctic Radiation-Cloud-Aerosol-Surface Interaction Experiment (ARCSIX), based out of Pituffik, Greenland, was conducted from May to August 2024. An aircraft-aerosol time-of-flight mass spectrometer (A-ATOFMS) was deployed on the NASA Orion P-3 aircraft and measured the size and chemical composition of individual aerosol particles in real-time. The resulting single-particle dual-polarity mass spectra act as chemical fingerprints, allowing for the identification of individual particle types and sources. Multiple sources of mineral dust, both local and transported, were observed to contribute to the Arctic aerosol population. The contribution of local mineral dust sources will likely increase as the Arctic warms. This work will improve our understanding of mineral dust in the Arctic, and its impacts on the radiative budget, weather, and climate.

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8AD.6

Biofilm Formation Facilitates Niche Adaptation and Survival of Bacillus Species in Dust-Borne Bioaerosols. NAAMA LANG-YONA, Ella Lahav, Hilit Levy Barazany, Talal Salti, Liat Rahamim Ben Navi, Prem Anand Murugan, Ilana Kolodkin-Gal, *Technion - Israel Institute of Technology*

Long-distance microbial transport via dust events is projected to intensify globally. However, survival mechanisms of air- and dust-borne microorganisms (bioaerosols) and their contribution to global processes remain poorly understood. In this study, we characterized Bacillus species isolated from transitional season dust storms, previously identified as a significant component of the bioactive community of the dust microbiome. Our results demonstrated substantial diversification in growth and surface-associated biofilm formation, which we link to niche adaptation within heterogeneous dust particles. While most dust isolates formed biofilms, they exhibited varying preferences for media composition under standard laboratory conditions, extreme temperatures, and low humidity. Notably, sterile dust stimulated biofilm formation, growth, and matrix gene expression in B. subtilis, leading to robust biofilm development in key related dust isolates. This stimulatory effect surpassed that of inorganic, synthetic dust, suggesting a critical role for organic substrates derived from decayed dust-community members. We further present findings on the metabolic potential and morphological characteristics of these communities in relation to shifting environmental parameters. Overall, these findings offer direct evidence that biofilm formation serves as an adaptive mechanism in the unique habitat of dust particles, facilitating microbial survival during long-range transport. These results hold significant implications for terrestrial and aquatic ecology, and public health, identifying a pivotal process by which bacteria survive and evolve in this understudied atmospheric niche.

8AE.1

Understanding the Fate of Airborne Particles in a Classroom: Advanced Numerical Modeling and Measurements. ROY KING, Suresh Dhaniyala, *Clarkson University*

The importance of monitoring and managing indoor air quality has grown with the increasing frequency of wildfires in the US and the awareness around airborne infection spread in indoor spaces. Currently, our knowledge of control of indoor air quality is largely based on theoretical models and experiments in ideal spaces with uniform location of aerosol sources and ports for air flow injection and removal. Real-world indoor spaces have ventilation systems and particle sources that are non-uniformly distributed in space and time, and the effectiveness of existing models to capture fate of aerosol in these spaces needs to be established. Over a multi-year time period, we monitored aerosol concentrations in an actively used classroom with variable intensity of usage, and determined that well-mixed theoretical models are inadequate for explaining aerosol fate in such as space. Subsequently, we conducted 3D, unsteady computational fluid dynamics (CFD) flow simulations and combined it with unsteady injection of particles representing student emissions and contribution of MERV-filtered outdoor air. The resultant predictions of concentration of particles in the room as a function of time was compared against particle measurements in the room and the ventilation system. In this presentation, we will discuss details of the numerical modeling and the experimental validation efforts and key findings around particle fate in indoor spaces.

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8AE.2

Modeling Wildfire Smoke Infiltration to Determine Residential Building Parameters and Meteorological Factors Influencing Indoor Particulate Matter Concentrations.

RILEIGH ROBERTSON, Marina Vance, Surya Goda, *University of Colorado Boulder*

Indoor particulate matter (PM) concentrations are elevated under the influence of wildfires and certain parameters will influence infiltration depending on home characteristics and ambient conditions. CONTAM is a multizone indoor air quality and ventilation analysis program developed by the National Institute of Standards and Technology that is designed to determine airflows, contaminant concentrations, and personal exposure in buildings. In CONTAM, we conducted simulations on a suite of over 200 homes that represent 80% of the United States housing stock using ambient conditions measured at the Elk Fire in October of 2024 in Wyoming. We used latin hypercube sampling (LHS) to obtain 100 different conditions to run in each home. This allowed for a more uniform sampling of the parameters that guarantees that the entire range of the input domain is included. It requires fewer iterations than random sampling for the same statistical accuracy. After running every home for each LHS input, we used multivariable regression to determine the most influential factors in smoke infiltration. Further, clustering and random forest were used to group similar homes based on their characteristics. We found that wind speed, mechanical ventilation filter efficiency, and temperature influence smoke infiltration the most, and several emerging themes in home characteristics are evident such as the influence of the presence of garages, basements, and attics. This work helps to identify the characteristics of homes where residents may be at higher risk of PM exposure and determines approximate indoor concentrations depending on plume concentrations.

8AE.3

An Integrated Platform for Open-Burning Aerosols Generation, Low-Cost Sensor Evaluation, and Toxicological Characterization.

SHUBHAM SUNIL SHARMA, Dhruv Mitroo, Yuezhi (August) Li, Yuxuan Ren, Benjamin Kumfer, *Washington University in St. Louis*

Combustion-generated aerosols from open-air burning sources including wildfires, landfill fires, and military burn pits adversely affect respiratory, neurological, and cardiovascular health. Laboratory studies that simultaneously integrate aerosol generation, exposure monitoring, and toxicological characterization from such sources remain limited. We developed a laboratory-scale solid-fuel burner platform capable of sustained combustion of mixed solid fuels under controlled conditions, enabling the investigation of combustion-generated aerosols from solid waste found in real-world open-burning. The platform was operated using mixtures of wood pellets, recycled paper, plastics, and biomass feed. Aerosols were characterized using SMPS, DustTrak™, gravimetric filter sampling, and elemental/organic carbon analysis. The platform demonstrated stable, repeatable aerosol generation, producing particles with consistent physicochemical properties across runs. Particulate Matter (PM) data collected simultaneously from commercially available low-cost optical sensors were also evaluated. All sensors consistently underestimated PM mass concentrations. Review of the data suggested this was primarily due to limited sensitivity to ultrafine particles, which dominated the aerosol size distribution. Despite this bias, sensors consistently captured temporal variability and showed a strong agreement with gravimetric measurements. Sensor response exhibited strong dependence on fuel composition, potentially highlighting the influence of physicochemical properties and the need for source-specific calibration strategies. Additionally, to assess toxicity, filter-collected aerosols were analyzed using acellular oxidative potential assays and in vitro cytotoxicity with A549 cells. Results demonstrate a range of cytotoxicity across fuel conditions, linking the physicochemical composition of aerosols to biological response. This study establishes an integrated experimental framework that bridges controlled combustion aerosol generation, real-time evaluation of sensor performance, and toxicological assessment. This study also highlights that both sensor accuracy and particle toxicity depend on physicochemical properties of the particles, and that further investigation is warranted to develop a low-cost sensor-based exposure risk assessment.

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8AE.4

Biological Exposure Studies to Simulated Atmospheric Pollutants Using a Smog Chamber: Insights from Synchrotron Radiation Imaging. AMBRE DELATER, Mathilde Ropiquet, Christina Vasilakopoulou, Lucy Gerard, Clément Buissot, Anouk Marsal, Mathieu Cazaunau, Edouard Pangui, Bénédicte Picquet-Varrault, Gaëlle Uzu, Sophie Lanone, Patrice Coll, *Université Paris Cité and Univ Paris Est Creteil, CNRS, LISA*

We know that air pollution poses a significant global challenge due to its associated health risks. However, the health effects associated with Air Quality are still under investigation. An important matter is to determine whether pollutants can be deposited in the lungs. To perform such a study, we developed the PolluRisk platform. It involves exposing mice housed in a cabinet to a realistic ambient pollution generated in a smog chamber (https://www.cesam.cnrs.fr/) for several days. During one campaign, we performed two experiments: 1) exposure to CuSO4 (20-50 ng/m^3) and FeSO4 (300 ng/m^3) particles and 2) exposure to dust particles (Arizona Test Dust, ATD) (100-150 µg/m^3). We exposed mice to one of these pollution episodes for 3 days. In parallel, for each experiment, an additional group of mice was housed in another cabinet that was only supplied with filtered air from the same laboratory, serving as a control group. We analyzed lungs samples with synchrotron radiation (ESRF, beamline ID21) and conducted two OP (oxidative potential) assays (AA: ascorbic acid; DTT: dithiothreitol) of particles collected on filters in both experiments. The preliminary results showed that exposure 2 led to higher content of particles deposited into mice's lungs in comparison with exposure 1. The OP^{DTT} was higher for exposure 1 (0.149 $nmol.min^{-1}.\mu g^{-1}$) than for exposure 2 (0.066 and 0.071 $nmol.min^{-1}.\mu g^{-1}$). Similar observations were made with OP^{AA} with 0.243 $nmol.min^{-1}.\mu g^{-1}$ for exposure 1 and 0.006 and 0.016 $nmol.min^{-1}.\mu g^{-1}$ for exposure 2. Therefore, we observed contrasting results in terms of OP between exposure 1 and exposure 2. The latter could be related to a difference in terms of particle solubilities. To go further, we plan to ICP-MS analyses, to quantify lung metal content, complementing the elemental mapping obtained with synchrotron radiation.

8AE.5

Human Ozone Exposure and Autoxidation Lead to New Particle Formation in Indoor Environments. KIEUDIEM NGUYEN, Meredith Schervish, Pascale Lakey, Suwhan Yee, Teresa Palacios Diaz, Madeline Cooke, Lena Gerritz, Lisa Wingen, Shen Yang, Nijing Wang, Tatjana Arnoldi-Meadows, Jonathan Williams, Dusan Licina, Donghyun Rim, James Smith, Manabu Shiraiwa, *University of California, Irvine*

Indoor air quality plays a critical role for human exposure to indoor air pollutants. Recent studies have revealed that human skin ozonolysis can induce the formation of nanocluster aerosols (NCAs, sub-3nm particles) followed by the growth of secondary organic aerosol (SOA) in indoor environments. However, the mechanisms underlying the first step of particle formation and the nucleating species remain poorly understood. Here we observe the formation of highly oxygenated molecules (HOMs) from the reactions of ozone with squalene in a flow tube reactor by using nitrate chemical ionization interface coupled to a high-resolution Orbitrap mass spectrometer (CI-Orbitrap). We also apply kinetic modelling coupled with a radical volatility basis set to simulate the observed formation of NCAs, and their subsequent growth in a controlled-climate chamber driven by the autoxidation of squalene ozonolysis products. Our results show that autoxidation of squalene ozonolysis products leads to the formation of HOMs, some of which reach ultra-low volatility organic compounds (ULVOCs), driving nucleation to form NCAs. We show that size-dependent particle losses can lead to the observed multi-wave particle formation and growth. We also demonstrate that the operation of mixing fans can restrain particle formation and growth by enhancing the deposition of particles and gas-phase species to the chamber wall, thereby having a direct impact on particle dynamics. These results improve our understanding of the particle formation pathway and have important implications for human exposure to ultrafine particles in indoor environments.

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8AE.6

Characterizing Aerosol Emissions from Musical Activities: Insights from Singing and Wind Instrument Performance.

CHIEN-YU HSU, Jun Wang, *University of Cincinnati*

Human respiratory activities, including singing and wind instrument performance, generate aerosols that contribute to the transmission of airborne diseases. The COVID-19 pandemic highlighted major knowledge gaps regarding aerosol emissions from musical activities, leading to widespread disruption due to uncertainty about exposure risks. While aerosol generation from breathing, speech, and singing has been widely studied, emissions from instrumental performance received limited attention before the pandemic.

Recent investigations demonstrate that aerosol emissions during wind instrument performance are strongly influenced by instrument design, sound intensity, playing technique, and performer physiology. Aerosol concentrations increase with sound pressure level, approximately 10% per 1 dBA; however, this relationship varies by instrument type, with clearer intensity-dependent trends observed in straight-tube instruments than in air-jet or complex-tube designs. Articulation patterns and individual respiratory behaviors further contribute to instrument-specific variability. Relative to background levels, singing substantially elevates aerosol concentrations, while wind instrument performance produces smaller but measurable increases. Compared with normal speech, instrument performance generally generates higher aerosol concentrations, comparable to singing at moderate loudness; however, particle size distributions resemble those of breathing and result in lower overall aerosol mass. Aerosol plumes from speaking, singing, and instrument performance are highly three-dimensional, unsteady, and spatially variable, yet can remain elevated at distances up to 10 ft from the source, exceeding the 6 ft distancing guideline. Mitigation strategies, including masking and appropriately sized HEPA filtration, significantly reduce near-source concentrations and background aerosol levels.

Despite recent advances, existing studies use different experimental designs, subject populations, and measurement methods, contributing to inconsistencies across published results. Most studies also focus on isolated factors rather than integrating multiple physical and physiological determinants of aerosol generation. Therefore, standardized measurement methods and systematic multi-factor approaches are needed to improve exposure assessment and support evidence-based risk management strategies for musical performance environments.

8AE.7

Tackling India's Air Pollution Requires Focusing on Informal Sources.

LUCAS ROJAS-MENDOZA, Bujin Bekbulatb, Libby H. Koolik, Yuzhou Wang, Cassidy Barrientos, Neeldip Barman, Krishnendu Barman, Piyush Bhardwaj, Srinidhi Balasubramanian, Chandra Venkataraman, Julian Marshall, Joshua S. Apte, *University of California Berkeley*

India, home to 18% of the world's population, experiences some of the highest $PM_{2.5}$ concentrations in the world, yet progress toward clean air goals has been limited by urban-centric policies that are misaligned with dominant emission sources. Here we develop the first India-specific InMAP source-receptor matrices (ISRMs) to quantify how emissions from informal sectors (domestic, agriculture, medium-small industry, and waste-fires) and formal sectors (heavy industry, transport, and energy) in rural and urban areas contribute to $PM_{2.5}$ concentrations and exposure from the national to the grid level. Informal sectors account for 66% of India-level $PM_{2.5}$ exposure and more than half of exposure in 26 of 36 states and union territories, home to 75% of India's population, regardless of pollution level or population size. Informal emissions originate predominantly in rural areas (80–83% of informal primary $PM_{2.5}$, VOC, and NH_3 emissions), making informal rural emissions the largest source of $PM_{2.5}$ exposure (43%) and about one third of urban residents' exposure. Hypothetical scenarios show that halving informal rural emissions reduces India-level $PM_{2.5}$ exposure by 21% compared with 13% from halving formal urban emissions and benefits urban and rural residents about equally. Formal urban emissions nonetheless remain the largest source of grid-level $PM_{2.5}$ concentrations for 19% of the population mostly in and around urban areas. These findings largely hold across three urban definitions and 22 sensitivity tests. Our results show that India's clean air goals cannot be achieved through urban-focused mitigation alone. The ISRMs provide a scalable, easy-to-use framework for informing air quality strategies.

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8ES.1

A Compact GC-PTR-TOF-MS for the Monitoring of VOCs.

MEGAN CLAFLIN, Brian Lerner, Manjula Canagaratna, John Jayne, *Aerodyne Research, Inc*

Long-term, routine monitoring of volatile organic compounds (VOCs) is needed to provide insight into emission sources and patterns, oxidation processes including photochemistry and radical cycling, and the formation of tropospheric ozone and secondary organic aerosol. However, instrumentation that can provide high quality data both in terms of temporal resolution and molecular speciation has historically been cost-prohibitive, and requires advanced users for field deployment, operation, and data analysis.

While the use of proton transfer reaction mass spectrometry, paired with time-of-flight technology (PTR-TOF-MS), has been utilized for the detection of VOCs in a wide variety of environments and measurement platforms; this technique cannot provide molecular structure information and suffers from detection interferences such as fragmentation, cluster formation, and mixed ionization schemes that complicate data analysis and interpretation. Combining in situ gas chromatography (GC) with PTR-TOF-MS is a remedy, offering isomer level resolution and the ability to easily quantify product ion distributions to account for complex detection schemes. The addition of chromatographic pre-separation not only enhances the accuracy of species typically reported by PTR methods, it can also be used to broaden the scope of VOC quantified using PTR methods, while maintaining low limits of detection (typically 1 ppt) without losing high time resolution data and negating the need for high mass resolving power.

Here, we demonstrate a new instrument package for the online detection of VOCs consisting of an in situ GC system equipped with an integrated thermal desorption (TD) system coupled to an ultra compact PTR-TOF-MS. The entire instrument is contained in a 50 x 65 x 55 cm footprint, weighs < 70 kg, and consumes < 600 W for typical operation. Coupling the GC system with the PTR-TOF allows the automated acquisition of both direct, high-time resolution data (e.g. 1 s) and pseudo-continuous molecular speciation data for isomer separation and improved quantification of the direct-PTR data. This compact, easier to operate and maintain system makes it feasible to utilize this technology for long term monitoring applications or complex deployments where space/power/access are limited or mobility is needed.

8ES.2

Single-Channel and Dual-Channel: Applications for the OmniCount(TM) Portable Water-Based CPC.

ANDREA J. TIWARI, Lucia Bustin, Patrick Roth, Florian Dahlkötter, Torsten Tritscher, Daniel R. Troolin, Oliver Bischof, Carsten Kykal, *TSI Incorporated*

OmniCount Portable Water-based Condensation Particle Counters (PWCPCs) are now available as single- and dual-channel versions (Models 3001/3002, TSI Incorporated, Shoreview, MN, US). Both models perform measurements in any physical orientation, and use distilled water as a working fluid. These attributes allow the OmniCount PWCPC models to enable accurate particle number concentration measurements – up to 200,000 #/cm3 – in a wide range of personal exposure settings, as well as drone-based applications. The Dual Channel version (Model 3002) allows for synchronized measurements at two locations, or alternatively, with different sample conditioning (e.g. catalytic stripper) for one channel.

This presentation will focus on both OmniCount PWCPC models from an application perspective. We will share data collected in various settings requiring portable instrumentation: an airplane cabin, car, bicycle, and various pedestrian-oriented environments. The talk will feature both filtration applications (e.g., airplane cabin filters), as well as exposure characterization (e.g. light-duty commercial vehicles). For example, our measurements revealed that defective exhaust emission filters can result in curbside concentrations far exceeding 200,000 #/cm3 when driving uphill.

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8ES.3

Diverse Environmental Testing & Evaluation Control Technology (DETECT) System. ANDY TOLLEY, Anthony Pacheco, David Borth, *Ambilabs*

Increasingly heightened concerns about environmental contaminants necessitates a research grade, customizable, accurate, precise, real-time, easily deployable, and flexible yet comprehensive monitoring system solution. Critical applications include; Situational environmental analysis; Air monitoring advanced research; Smoke monitoring; Emergency Response; Corrosion monitoring; Industrial facilities monitoring; AI Data centers monitoring. Various individual complex sensor technologies have become available, each with dedicated, unique operating, calibration and communication requirements. However, to enable new sensor technological solutions to serve mission needs effectively, a homogenous, temperature controlled support platform with customizable and interchangeable sensors/modules would be beneficial, whereby data control, calibration, and sensor operations are integrated into a compact, single operational platform able to operate in a diverse range of environmental conditions. Deployment of this type solution presents many unique challenges, and to meet these challenges, Ambilabs adapted and utilize a turnkey Diverse Environmental Testing & Evaluation Control Technology (DETECT) system, which is then able to seamlessly incorporate multiple detection sensors within a single, easily deployable, homogenous platform, for the purpose of providing a real-time solution to accurately and quickly analyze situational environmental conditions, be easily deployed across multiple locations, and able to serve multiple different needs for the widest possible range of environmental monitoring and control applications. The Ambilabs DETECT system development was partially funded via a SBIR (Small Business Innovation Research) grant in partnership with the US Department of Defense (previously DoD, now DoW). As such, future use applications using federally funded monies which are utilizing a DETECT solution may be able to benefit from a no-competition “sole source” funding arrangement for procurement purposes via a SBIR Phase 3 contracting mechanism. Please discuss with Ambilabs personnel for additional information concerning future DETECT funding opportunities for research and operational projects.

8IM.1

A Next-Generation Aerial Micro-Aerosol Sampler (MAS). ALYSSA ALSANTE, Thien Nguyen, Joe Baldwin, Mike Benson, *Oak Ridge National Laboratory*

Cascade impactors are widely used and commercialized, but the conventional system has limitations when applied as a portable and aerial collection device. An unmanned aerial system (UAS) can locate and selectively collect aerosol in situ to significantly increase the signal for source identification, apportionment, and improving our understanding of atmospheric science. Therefore, a micro-aerosol sampler (MAS) with a total weight of <70 g in an aluminum body was developed to collect aerosol on a UAS based on the principle of cascade impaction. The MAS prototype was developed for simultaneous collection and detection of radiological aerosol for nuclear forensics applications. This advanced, autonomous aerial sampling platform was produced using a customized impactor design to minimize size, weight, and power requirements uniquely suitable for aerial applications. Computational fluid dynamics (CFD) and experimental approaches were combined to maximize collection efficiency within a short sampling time and concentrate aerosol for further automated analysis. The MAS contains four impaction plates with a size-cut (D_{50}) at 5, 2.5, 1, and 0.5 µm that represents the aerodynamic diameter at which a stage collects 50% of the total particles. The MAS was experimentally evaluated using fluorescent polystyrene latex (PSL) spheres at nine nominal sizes ranging from 0.1 to >3 µm and other standardized particulate matter (i.e., Arizona Test Dust and Carbon Black) at each impaction stage. The theoretical and experimental results are consistent with reported performance at >90% collection efficiency for particle sizes greater than each size-cut. MAS evaluation efficiency and operational capabilities under relevant environmental conditions and in an urban field application will be discussed.

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8IM.2

Aerodyne Aerosol Mass Spectrometer Light-Scattering Collection Efficiency Measurements of Smoke from Laboratory Burns of Wildland Fuels. ANN M. MIDDLEBROOK, Alessandro Franchin, *NOAA Chemical Sciences Laboratory*

One of the key uncertainties in the Aerodyne Aerosol Mass Spectrometer (AMS) and Aerosol Chemical Speciation Monitor (ACSM) measurements is the collection efficiency (CE), which incorporates aerodynamic lens transmission, particle beam focusing (mainly for AMS instruments), and particle bounce off of the vaporizer. Laboratory and field studies indicate that particle phase is an important factor in whether or not particles bounce off the vaporizer prior to evaporating. While an algorithm to calculate the bounce-related CE based on the inorganic components and sampling line relative humidity has been used with fairly reproducible results, the organic effect on CE is less well-understood. Past evaluation of field measurements with increasing organic mass have not shown any specific effects of the organic composition. Yet, there might be hints of differing collection efficiencies for urban secondary organic aerosol (SOA) and biomass burning OA. Laboratory measurements from fresh SOA indicate that the CE decreases with increasing fraction of oxidized ions.

In the fall of 2016, we performed experiments at the U. S. Forest Service Missoula Fire Sciences Laboratory aimed at examining the properties of fresh smoke from a variety of wildland fuels with several different instruments. We used a compact time-of-flight aerosol mass spectrometer equipped with a light-scattering module and an AP240 data acquisition card, which can obtain light scattering data and corresponding mass spectra from single particles (LSSP). In LSSP mode, a particle detected by the laser may or may not have detectable mass spectra and this metric defines the CE measured by light scattering or CE_{LS}. Here we present measurements of CE_{LS} for fresh, diluted smoke and smoke that had passed through a thermodenuder and/or a small oxidation chamber. We will present these results and comparisons of them with prior CE studies of organic aerosols.

8IM.3

Characterization of a Hydration Spectrometer (HySpec) System for Studying Aerosol Cloud Interactions. OGOCHUKWU ENEKWIZU, Ernie R. Lewis, Arthur J. Sedlacek, *Brookhaven National Laboratory*

Aerosol-cloud interactions contribute the largest uncertainties to estimates of the Earth's energy budget because of the poor quantification of fundamental microphysical and chemical processes. A key process is the formation of cloud residuals – aerosol particles that undergo cloud processing and are left behind after cloud drop evaporation. These aerosol particles reenter the atmosphere with different microphysical, chemical, and optical properties than the cloud condensation nuclei (CCN) that formed the cloud drop and thus interact with incoming solar radiation or influence clouds differently. The measurement of cloud residuals is, however, challenging and often limited to either aircraft campaigns or mountain site stations that employ a counterflow virtual impactor (CVI) to separate the generally larger cloud residuals from smaller aerosol particles based on their inertia. Here, we integrate a pumped CVI (PCVI), developed for laboratory applications, with a modified CCN counter to isolate and sample cloud residuals in a controlled laboratory setting. Dry aerosol particles introduced to the CCN-PCVI, which we refer to as a Hydration Spectrometer system, are first exposed to supersaturation conditions in the CCN counter that will cause some particles to activate. The resulting population of cloud droplets and non-activated particles are immediately drawn into the PCVI, where a particle-free flow of gas directed opposite the particle-laden flow provides a controllable means of separating the non-activated aerosol particles while allowing cloud droplets to be transmitted. Cloud droplets exiting the PCVI are dried prior to subsequent analysis, forming residuals, and their microphysical and optical properties are quantified. We report the efficacy and performance of the Hydration Spectrometer system for different particle types and sizes over a range of flow and supersaturation conditions.

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8IM.4

Molecular-Level Source Apportionment and Semi-Quantitation of Secondary Organic Aerosol Measurements Using Machine Learning and High Resolution Mass Spectrometry. GREGORY W. VANDERGRIFT, Sining Niu, Nurun Nahar Lata, Ashfiqur Rahman, Zezhen Cheng, Swarup China, *Pacific Northwest National Laboratory*

The molecular level complexity of organic aerosol in field samples often complicates the simultaneous pursuit of quantitative and qualitative information, particularly at the molecular level. Here, we present a new workflow and automated data processing pipeline for high resolution mass spectrometry (HRMS) datasets that provide semi-quantitative per-sample measurements while still preserving molecular-level selectivity for source apportionment and mechanistic investigations. We focus on organosulfates here due to important applied factors, such as their role in multiphase chemistry. The chemical nature of organosulfates also promotes significant technical advantages given their high acidity and propensity to form chemically similar negative ions in mass spectrometry ionization sources. Expanding on this idea, we first demonstrate comparable molar-level sensitivities for a variety of co-present, structurally diverse organosulfates with a nanospray ionization source and HRMS. We then use nanospray desorption electrospray ionization to directly sample organic aerosol from Teflon filters, with a constant, known concentration of organosulfate internal standards in the system solvent. We analyze over 200 samples from ARM field campaigns (TRACER, SGP, SAIL, BNF, COURAGE), unambiguously assigning molecular formulas on a per-sample basis, with this internal standard approach. Given that there is no time-resolved separation, all sample organosulfates and internal standards experience uniform matrix effects, regardless of the tested sample. Response factors are therefore generated to show extension of the internal standard signals to semi-quantitate sample organosulfates. Using a machine learning algorithm and correlation with known organosulfate tracer formulas, we inform time-resolved trends in discrete classes of molecular level signals (e.g., isoprene derived organosulfates). Furthermore, via correlations with ground-level ACSM measurements, we validate the use of measured HRMS intensities to inform total sample abundance, permitting semi-quantitative information from untargeted molecular level measurements. Overall, this strategy represents a powerful framework for linking molecular identity to abundance, improving source apportionment of organic aerosol, and informing mechanistic investigations of aerosol ageing.

8IM.5

The Impact of Optical Measurement Techniques on Measured Aerosol Particle Size Distributions. JESSICA GASPARIK, Ernie R. Lewis, Janek Uin, *Brookhaven National Laboratory*

Optical particle counters (OPCs) are routinely used to determine optical size distributions of aerosols. Particle size is determined by comparing the amount of light, at a given wavelength and polarization, that is scattered by a measured particle to the amount scattered by a uniform spherical particle with a known refractive index (typically polystyrene latex). This study investigates how differences in refractive index between the measured particle and calibration particle affect OPC-derived size distributions of ambient aerosols.

We find that differences in aerosol refractive index manifest in the measured optical size distribution determined by the Ultra-High Sensitivity Aerosol Spectrometer (UHSAS) OPC as: (1) differences in the magnitude of the measured optical diameter, and (2) the appearance of modes at ~600 nm and ~850 nm. These modes are observed in ambient size distributions determined by the UHSAS across diverse global locations but are absent in collocated Grimm OPC measurements.

Computer models of the UHSAS (“digital UHSAS”) and the Grimm (“digital Grimm”) are constructed using Mie theory. Optical size distributions are simulated for aerosols with a structureless geometric size distribution (i.e., no modes) and uniform spherical particles with refractive indices of 1.40, 1.45, 1.50, and 1.574. Differences in the magnitude of the measured optical diameter are attributed to the differences in refractive index from that of the calibration aerosol. The appearance of modes in UHSAS measurements arises from the nonlinear relationship between the amount of light scattered and the geometric diameter, whereas their absence in Grimm measurements is attributed to its coarser bin spacing.

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8IM.6

Not All Tandem Classifier Systems Are Created Equal.

Morteza Kiasadegh, Timothy Sipkens, Jonathan Symonds, JASON S. OLFERT, *University of Alberta*

Many aerosol measurement techniques rely on aerosol classifiers to select quasi-monodisperse fractions of a selected particle property from polydisperse distributions. Although such classifiers are well established for single property characterization, resolving the inherently multidimensional nature of atmospheric particles necessitates tandem measurement configurations. In these systems, the measured response represents a convolution of the true particle property distribution with the instrumental transfer functions, with additional contributions arising from multiple charging.

While inversion frameworks have been extensively developed for mass–mobility and refractory black carbon–total mass distributions, comparatively little attention has been given to the two-dimensional mass–aerodynamic diameter (m–d_a) distribution. As recently shown by Hassim et al. (2025), for non-spherical particles, simplified peak-fitting approaches may introduce significant bias in retrieved parameters, particularly when aerodynamic diameter is one of the classified variables.

In the present work, several inversion schemes are implemented to reconstruct the two-dimensional m–d_a distribution from tandem measurements combining a Centrifugal Particle Mass Analyzer (CPMA) and an Aerodynamic Aerosol Classifier (AAC). Synthetic datasets are first employed to systematically assess the performance of each inversion approach for both narrow and broad distributions. In addition to simulated cases, DOS and soot particles are experimentally investigated as representative examples of narrow and broad distributions, respectively. To further constrain the inversion, one-dimensional aerodynamic diameter distributions obtained with the AAC while the CPMA is bypassed are used to match the marginal distributions derived from the CPMA–AAC inversion.

The performance of each inversion scheme is then evaluated based on its reconstruction accuracy, assessed through comparison of the recovered marginal distributions with independently measured aerodynamic and mobility diameter distributions. Overall, this framework provides a systematic basis for assessing the reliability of m–d_a reconstructions and for comparing reconstruction accuracy across different regularization approaches for both narrow and broad distributions.

8IM.7

Theoretical and Experimental Characterization of Low-Cost Sensor Response Function.

SREEKESH KOOKKAL, Suresh Dhaniyala, *Clarkson University*

Air quality monitoring is critical for understanding the health and environmental impacts of airborne particulate matter (PM). Usage of low-cost optical sensors (LCOS), such as those from Plantower and Sensirion, have become very popular for indoor and ambient monitoring. LCOS measurements are based on single-particle focused light scattering, with custom algorithms to estimate different mass concentrations, including PM1, PM2.5, and PM10. Recently, we theoretically modeled the response of PMS5003 and SPS30 sensors to determine their detection efficiency as a function of particle size and showed that the sensors have an increasing detection efficiency with particle size. Here, we extend that study, by measuring size-dependent particle transmission efficiencies through the two LCOS units (Plantower and Sensirion). The experimental results show that sampling efficiencies decrease with particle size for sizes larger than ~ 2 µm. Combining the theoretical detection efficiency with the measured transmission efficiencies provides the number-concentration response function of the two sensors. In this study, we will present the response function calculation approach for the reported number and mass concentrations for the two sensors. The knowledge of response functions allows us to understand the relation between the sensor reported values and the sampled particle size distribution.

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8SA.1

Integrated Source Apportionment of VOCs and Secondary Organic Aerosol Tracers Using Adjusted Initial Concentrations and Time-Shifted PMF. YI-HSIEN LIU, Chun-Sheng Huang, Chia-Yang Chen, Ze-Ying Chen, Chang-Fu Wu, *National Taiwan University*

Positive Matrix Factorization (PMF) is widely used for VOC source apportionment, yet photochemical losses and the presence of hyperlocal emission sources (HLS) can introduce biases in the apportioned source profiles and contributions. This study proposes an improved framework integrating adjusted initial VOC concentration (IVOC) estimation with a time-shifted secondary organic aerosol (SOA) tracer approach, applied to a highly industrialized site in southern Taiwan, where VOC and $PM_{2.5}$ organic molecular tracer data were collected across four seasons during 2024–2025.

Three PMF models were developed and compared. The baseline model (M0) used measured VOC concentrations without photochemical correction. M1 incorporated IVOC estimation using the photochemical-age-based parameterization method. In M2, a two-stage PMF procedure was introduced to identify and exclude HLS contributions prior to IVOC calculation, given that near-source emissions have not undergone equivalent photochemical processing and would otherwise bias the photochemical age estimation. This adjustment reduced the petrochemical emission contribution from 44% (M1) to 27% (M2) and enabled the separation of previously merged LPG and gasoline evaporation factors. Model 3 (M3) further incorporated SOA molecular tracers alongside VOC data using a multiple time-resolution PMF framework, with SOA time-shifted by 12 and 24 hours to capture the temporal lag between VOC emissions and secondary aerosol formation. M3 resolved nine factors, including a photochemically aged air mass factor and a biomass burning factor, providing linkages between VOC precursors and their secondary products.

These findings provide a more robust characterization of VOC emission sources and their secondary formation pathways, with implications for air quality management in petrochemical-dominated regions.

8SA.2

Multi-Year Variability of Cooking Organic Aerosol in the San Joaquin Valley Using Rolling-Window PMF of ACSM Measurements. ASHUTOSH KUMAR SHUKLA, Justin Trousdell, Wenqing Jiang, Chinmoy Sarkar, Morteza Amini, Qi Zhang, *University of California, Davis*

Cooking organic aerosol (COA) is an important component of urban PM2.5, but its long-term variability remains poorly constrained because COA is difficult to separate from co-emitted sources, is strongly influenced by meteorology, and rarely measured over multi-year periods with aerosol mass spectrometry (AMS). Here, we quantify COA variability in California's San Joaquin Valley using continuous Aerosol Chemical Speciation Monitor (ACSM) measurements at two urban sites, Fresno and Bakersfield, from summer 2023 to summer 2025. Fresno represents spatially distributed urban cooking emissions, whereas Bakersfield is influenced by denser commercial cooking activity near measurement site.

Time-resolved organic aerosol (OA) sources were obtained using rolling-window Positive Matrix Factorization (PMF) within the ME-2 framework. The analysis used overlapping 7-day windows advanced every 6 hours, allowing source profiles and contributions to evolve over time. Primary OA (POA) factors, including hydrocarbon-like OA (HOA), biomass burning OA (BBOA), and COA, were constrained. The COA constraint was informed by a hybrid reference spectrum combining literature AMS profiles with ACSM-compatible profiles derived from co-located HR-AMS and I-CIMS measurements.

COA was consistently resolved as a distinct POA factor at both sites, contributing approximately 10–11% of total OA. In Fresno, COA average concentrations ranged from ~0.7–0.9 $\mu g.m^{-3}$, representing ~6–12% of OA and ~26–35% of POA. Bakersfield exhibited higher average COA concentrations in 2023 (~1 $\mu g.m^{-3}$), followed by a decrease in 2024-2025 (~0.6–0.8 $\mu g.m^{-3}$), while fractional contributions remained relatively stable. Diurnal patterns revealed persistent evening enhancements at both sites. Fresno exhibited stronger, seasonally pronounced peaks, particularly during winter and fall, whereas Bakersfield showed flatter diurnal profiles with occasional warm-seasonal morning enhancements. These results demonstrate long-term ACSM measurements combined with rolling PMF can resolve multi-year COA variability and distinguish spatially and temporally variable cooking emission patterns in complex urban environments.

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8SA.3

Non-tailpipe Emissions as a Source of Urban Organic Aerosol: Laboratory Characterization and Near-Roadway Source Apportionment. DHIVYA MANICKAM, Samuel La Salle, Madeline Cooke, Lisa Wingen, Adam Thomas, Berenice Rojas, Véronique Perraud, Celia Faiola, Barbara Finlayson-Pitts, James Smith, *University of California, Irvine*

As the global automotive fleet transitions from combustion engine power to electric vehicles, non-tailpipe emissions (e.g., brake wear, tire wear) are becoming an increasingly relevant anthropogenic air pollution source. Continuous monitoring of this emerging source of pollutant is thus vital to assessing its impact on public health. The Aerosol Chemical Speciation Monitor (ACSM) is a deployable instrument that measures non-refractory aerosol particle composition in real time and is commonly paired with Positive Matrix Factorization (PMF) to apportion different aerosol sources. We present here ACSM measurements of submicron aerosol particles during laboratory studies of brake emissions and a field study at a heavily trafficked near-roadway site. Laboratory experiments were conducted using a custom-built dynamometer to generate brake wear particles from two common brake pad types (ceramic and semi-metallic brakes) under various braking conditions. Mass spectra of the brake wear particles indicated the presence of cyclic amines recently identified in tire and brake samples, with distinct features including ions at m/z 138 and 56, confirmed with high resolution standard measurements. To determine the contribution of non-tailpipe emissions to ambient organic aerosol (OA), the ACSM was deployed to an I-710 freeway field site in Long Beach, California. Source apportionment of the OA fraction was conducted with PMF to deconvolute a total of five factors. One novel factor was assigned to non-tailpipe emissions based on its unique resemblance to the mass spectra obtained during the dynamometer experiments and diurnal trends coinciding with periods of vehicle deceleration and acceleration, with an average contribution of 12.5% to the measured submicron non-refractory OA particle mass at the near-roadway site. These findings demonstrate that non-tailpipe emissions can be identified and quantified in urban aerosol particles using real time aerosol mass spectrometry of the organic component, providing a complementary method to the use of metal tracers.

8SA.4

Positive Matrix Factorization Provides Insights Into Sources of Particulate Matter and Volatile Organic Compounds in the El Paso Area. SHIHAO ZHAI, Daniel H. Sung, Chun-Ying Chao, Kyle Druckman, Kacper Przykaza, Lea El Khoury, David Sullivan, Pawel K. Misztal, Lea Hildebrandt Ruiz, *University of Texas at Austin*

The El Paso, Texas, region is frequently affected by haze, with particulate matter (PM) concentrations often exceeding established air quality standards, raising concerns regarding human exposure and regulatory compliance. Data from ground-based monitoring sites show that yearly average $PM_{2.5}$ levels in the El Paso region surpass the new annual National Ambient Air Quality Standards (NAAQS) of 9 $\mu g/m^3$.

Results from mobile measurements conducted in January and May 2025 reveal hotspots for pollutants from various source types and identified four PMF factors of organic aerosol (OA) for both the winter and summer campaigns. In winter, traffic emissions from diesel and gasoline engines contributed to spikes in hydrocarbon-like OA (HOA), while restaurants and residential neighborhoods drove elevated levels of cooking-related OA (COA). Biomass burning OA (BBOA) was linked to firewood burning and residential heating. Additionally, more aged aerosol with higher O:C ratios was identified as oxygenated organic aerosol (OOA). During the summer, HOA and COA factors remained prevalent, alongside less and more oxidized oxygenated organic aerosol (LO-OOA and MO-OOA) driven by intense solar radiation. Variations in wind direction also influenced OA composition, reflecting shifting source impacts. During both seasons, we also identified key anthropogenic volatile organic compound (VOC) enhancements (e.g., BTEX and ethanol) that correlate closely with PM measurements. Overall, PMF results show seasonal emissions from traffic, heating, and cooking, coupled with photo-oxidation and wind direction, drive the spatial distribution and chemical age of gas- and particle-phase pollutants in the El Paso region.

We measured mixing ratios of VOCs and the concentration and bulk composition of fine particulate matter (<1 micron) using a van equipped with a Vocus 2R Proton Transfer Reaction Time-of-Flight Mass Spectrometer and a High-Resolution Time-of-Flight Aerosol Mass Spectrometer. We conducted source apportionment of OA using the positive matrix factorization (PMF) evaluation tool.

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8SA.5

Urban Cooking-Related Emissions: Interconnections and Divergent Behavior of Cooking Organic Aerosol and Gas-Phase Organic Compounds. DREW GENTNER, Jo Machesky, Anna Oehlerking, Mia Tran, Mitchell Rogers, Minguk Seo, Taekyu Joo, Tori Hass-Mitchell, Benjamin A. Nault, Joseph Roscioli, Jordan Krechmer, Adam Thomas, Paloma Lenz, Manjula Canagaratna, Andrew Lambe, *Yale University*

Cooking is a major source of organic aerosol in urban areas. Yet, its emissions, dynamics, and fate remain under-constrained, along with the emissions pathways and behavior of associated gas-phase organic compounds, including volatile organic compounds (VOCs). Using top-down urban measurements in Manhattan during the NYC-METS (New York City metropolitan Measurements of Emissions and TransformationS) campaign, we investigated the influence of particle- and gas-phase cooking-related emissions. We employed an aerosol chemical speciation monitor (ACSM) and multiple online high-resolution mass spectrometers to examine a diverse range of gas-phase organic compounds, and used positive matrix factorization (PMF) for source apportionment of both gases and aerosols. During summer 2022, we observed multiple gas-phase source factors associated with cooking, including VOCs previously attributed to cooking (e.g., nonanal, octanal, C7H10). Source factor contributions and ambient concentrations of individual gas-phase organic compounds associated with primary emissions peaked in the late evening but were not well-correlated with cooking-related organic aerosols (i.e., COA) derived via source apportionment of ACSM data. We also evaluated the collective temperature sensitivities of cooking-related sources as COA has previously been shown to exhibit temperature dependence at multiple sites in New York City, even when corrected for meteorology (Hass-Mitchell et al., ACS ES&T Air, 2024). We examined gas-phase source factors, along with individual cooking-related VOCs, for similar temperature dependences, and conducted laboratory experiments to cross-compare against our ambient observations. The results demonstrate the dynamic nature of gas- and particle-phase cooking-related emissions across multiple source pathways, as well as the influence of elevated temperatures and heatwaves. In all, these real-world top-down observations, supplemented by laboratory studies, expand our understanding of cooking-related source types, emissions pathways, and associated compounds—advancing knowledge on the composition, contributions, and dynamics of cooking-related emissions to inform emissions inventories and air quality modeling in a changing climate.

8SA.6

Sub-Daily PM2.5 Source Apportionment from Automated FTIR Spectroscopy: First Application of the U.S. EPA ESAT Toolkit to Infrared Aerosol Spectra. Andrea Baccarini, Carolina Molina, Eleni Liakakou, Aikaterini Bougiatioti, Nikolaos Mihalopoulos, Athanasios Nenes, Satoshi Takahama, NIKUNJ DUDANI, *Aerospec SA*

Source apportionment of fine particulate matter (PM2.5) traditionally relies on either offline filter analyses, which lack the temporal resolution to resolve diurnal source dynamics, or online mass spectrometric techniques, which are powerful but expensive and limited in their ability to characterize organic functional groups, mineral dust, and other refractory species. Fourier-Transform Infrared (FTIR) spectroscopy bridges this gap by quantifying a wide range of organic and inorganic aerosol components from a single measurement, but until recently has been restricted to filter-based, low-time-resolution deployments.

This contribution presents the first source apportionment study performed on online FTIR aerosol spectra acquired with the Aerosol InfraRed Monitor (AIRMon), an automated FTIR-based instrument developed by Aerospec SA. The AIRMon was deployed at the National Observatory of Athens (NOA), Greece, during March to April 2025, collecting 173 valid PM2.5 spectra at 4-hour resolution. We applied the U.S. Environmental Protection Agency (EPA) Environmental Source Apportionment Toolkit (ESAT), which implements non-negative matrix factorization (NMF), to the AIRMon spectral dataset. To our knowledge, this represents the first application of ESAT to infrared data.

The unconstrained factorization resolved six factors: ammonium sulfate (AS), ammonium nitrate (AN), mineral dust, fresh and aged biomass burning (BB) organic aerosol, and secondary sea spray, a marine-influenced factor that would be invisible to many traditional methods. Factor assignments were validated against laboratory reference spectra, previous chamber BB measurements, co-located ACSM measurements (SO_4: $R^2 = 0.72$; NO_3: $R^2 = 0.81$; total organics for fresh BB: $R^2 = 0.92$), AE33 black carbon ($R^2 = 0.72$ for fresh BB), and Grimm OPC coarse-mode PM ($R^2 = 0.77$ for dust). The 4-hour sampling resolution further enabled the reconstruction of factor-specific diurnal cycles and directional source signatures, features that are averaged out in daily filter sampling and demonstrate the value of automated FTIR for source-resolved air quality monitoring.

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8SA.7

Emerging Chemistry and Seasonal Drivers of Urban Aerosol Formation in Melbourne, Australia. EMILY FRANKLIN, Caleb Mynard, Erin Dunne, James Harnwell, Amanda Wheeler, Melita Keywood, *CSIRO Environment*

Fine particulate matter poses significant risks to public health and contributes to a range of health conditions for vulnerable populations including cardiovascular issues in seniors and paediatric asthma. Compared to the Northern Hemisphere, the Southern Hemisphere's urban aerosol has been significantly undersampled and understudied. As a result, source apportionment and dominant formation mechanisms are incompletely characterized; this is particularly problematic as climate change perturbs major sources such as heat waves and wildfires and human emissions change with evolving regulation and engineering controls. Here we present a full seasonal cycle (winter 2025-autumn 2026) of submicron aerosol chemical composition and source apportionment by aerosol chemical speciation monitor (ACSM) in Melbourne, the first such measurements reported from a populated site in Australia. While background particulate matter pollution levels are extremely low due to the dynamics of pristine Southern Ocean marine airmasses moving through the Melbourne airshed, wintertime fine particulate matter frequently exceeds 40 µg/m3, particularly overnight. These elevated pollution levels are driven by increases in both organic aerosol and ammonium nitrate, with evidence for distinct primary and secondary pollution formation regimes driven by residential biomass burning activities and meteorological conditions leading to stagnant airmasses. Summer particulate matter is predominantly organic with contributions from sulfate aerosol originating from Port Philip, with both shipping and algal blooms potentially contributing precursor materials. Summer extrema are driven by wildfire smoke events, although notably summer 2025/26 was not significantly impacted by smoke periods in the study region. This work's highly time resolved source apportionment of aerosol pollution provides valuable information to regulatory agencies in identifying and mitigating air pollution impacts on public health. The expansion of aerosol chemistry techniques broadly applied across the Northern Hemisphere creates unique opportunities to compare and contrast dynamics driving urban aerosol formation and fate in the Southern Hemisphere.

8WF.1

One Year of PHOENIX: Lessons Learned from a Dense Sensor Network for Outdoor PM Monitoring in Altadena, CA After the 2025 Eaton Fire. HAROULA D. BALIAKA, Coleen Roehl, Nikos Kanakaris, Manuel de la Torre Juárez, Merritt McDowell, Isaac Aguilar Rivera, Théo Tacail, François L.H. Tissot, Sina Hasheminassab, Thomas Morrell, Rima Habre, Nga Lee Ng, John Seinfeld, Richard Flagan, Paul Wennberg, *California Institute of Technology*

PHOENIX (Post-fire airborne Hazard Observation Environmental Network for Integrated Xposure-monitoring) is a dense outdoor air quality monitoring campaign established in Altadena, CA, following the January 2025 Eaton Canyon fire. PHOENIX consists of over 20 moderate-cost commercial sensors with real-time $PM_{2.5}$ and PM_{10} measurements at 1-minute intervals. The sensors are spaced approximately 1 km apart and are mounted on rooftops of schools, homes and businesses offering high spatial and temporal resolution information at the neighborhood scale. The network was able to provide an independent assessment of local air quality during post-fire cleanup and recovery in real-time. Its establishment was especially timely, particularly given that PM_{10} concentrations are heavily influenced by localized sources (e.g., fire debris and ash removal and transport) that are often missed by regional air quality monitors or pre-existing low-cost PM sensor networks (e.g, PurpleAir). Our results show that while daily average PM levels remained within EPA regulatory limits, sensors detected sharp early-morning PM_{10} spikes along major north-south roadways indicating potential resuspension of road dust. In addition, road dust samples collected in April, 2025 revealed elevated lead (Pb) concentrations. Here, we describe the quantitative capabilities of PHOENIX, initial findings, as well as other lessons learned over the first year of operation.

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8WF.2

Air Quality During and After the 2025 Southern California Fires and the Utility of Potassium as a Fire Tracer. CATHERINE BANACH, Kyle Caulson, Laura Thapa, Pablo Saide, Suzanne E. Paulson, *University of California, Los Angeles*

Wildland-urban interface fires are becoming more frequent, and their impacts on adjacent urban centers are rising. In January 2025, the Eaton and Palisades fires burned 5,674 and 9,489 hectares of wildlands and 10,488 and 7,810 and structures, respectively and blanketed parts of Southern California in smoke and dust. Here we combine hourly heavy metals, particulate matter, gasses, meteorology, airmass back trajectories, and fire spatial extent with several statistical methods to understand the fire impacts on air quality. The primary receptor site, about 28 km from the Eaton fire, was intermittently directly downwind. The smoke increased airborne lead concentrations by up to 250 times its background, to about 2% of PM2.5 mass; arsenic, chlorine, bromine and copper were also highly elevated. Concentrations of many elements associated with resuspended soil began to rise when high winds started immediately prior to the Eaton fire ignition, increased further after the fire started, and decayed once the winds decreased. Potassium, often used as a biomass burning tracer, was anti-correlated with smoke. While it was strongly associated with coarse particles, its mass-normalized concentration fell within its normal range during the fires, indicating potassium this cannot be used as a fire tracer in this context. Lead, an expected tracer for urban burning, remained elevated after burning in the urban areas ceased but wildlands continued to burn. There was no clear tracer of wildland burning in the smoke or coarse particles. Finally, we found little evidence of fire-associated pollution after the fires were extinguished.

8WF.3

Indoor and Outdoor Gas- and Particle-Phase Air Pollutant Levels During and After the 2025 Los Angeles Wildfires. YUAN YAO, Qiyue Nie, Jing Li, Muchuan Niu, Yihan Fan, Qiao Yu, Diane Garcia-Gonzales, Haoxuan Chen, Feng Gao, Michael Jerrett, Yifang Zhu, *University of California Los Angeles*

Wildfires at the wildland–urban interface (WUI) pose a growing public health threat, yet the chemical composition of wildfire smoke remains poorly characterized. During the January 2025 Los Angeles Wildfires, we conducted paired one-week indoor and outdoor air sampling at 22 smoke-impacted households spanning three fire phases: Phase 1 (active burning with <50% containment: January 8–15), Phase 2 (active burning with >50% containment: January 24–31), and Phase 3 (post-fire following 100% containment: February 11–18). We measured gas- and particle-phase air pollutants, including volatile organic compounds (VOCs), fine particulate matter ($PM_{2.5}$), and elemental compositions, and compared them with pre-fire urban levels. We found that outdoor air pollutant concentrations peaked during Phase 1 and declined rapidly as the fires were contained. Biomass-burning tracers (K, P), mineral and building material tracers (Ca, Sr), and toxic metals (Cd, Pb, Zn) were enriched indoors and outdoors per unit $PM_{2.5}$ mass in Phase 1. Notably, outdoor Cd, Pb, and Zn were enriched 23-, 10-, and 6-fold, respectively, relative to pre-fire urban $PM_{2.5}$. Indoor-to-outdoor (I/O) ratios of air pollutants were lowest during active burning and increased post-fire, with VOCs reaching median I/O ratios up to 3.4, while the median I/O ratios of $PM_{2.5}$ and elemental compositions generally remained below unity post-fire. These findings indicate that during active fires, toxic metals were substantially enriched in $PM_{2.5}$, suggesting increased toxicity of particulate pollution during peak smoke conditions. Post-fire, VOCs showed greater indoor persistence, whereas no clear indoor persistence of toxic metals was observed. Together, these results highlight differences between gas- and particle-phase air pollutants during and after WUI fires and underscore the need to incorporate both into health risk assessments and public health guidance.

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8WF.4

Ambient and Indoor Particle Composition in the Burn Zone and Nearby Neighborhoods After the 2025 Southern California Wildfires. CHUN-YING CHAO, Albert Kyi, Katarina Konon, Shihao Zhai, Chou-Hsien Lin, Evelyn Deveraux, Daniel H. Sung, Anna Neville, Lea El Khoury, Pawel K. Misztal, David T. Allen, Lea Hildebrandt Ruiz, *University of Texas at Austin*

The 2025 wildland-urban interface (WUI) fires in Southern California destroyed thousands of homes and structures, resulting in complex particle matter emissions. We investigated non-refractory submicron particulate matter (NR-PM_1) through high-resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS) measurements following the 2025 WUI wildfires in the Altadena and Pacific Palisades regions of Southern California. We deployed a mobile laboratory to measure in-situ aerosol composition and loadings in the burn zone and nearby neighborhoods in February and May 2025.

In February, ambient NR-PM_1 concentrations showed strong spatial and temporal variability. The Pacific Palisades, a coastal community impacted by the Palisades Fire, had lower mean NR-PM_1 concentrations than inland Altadena (location of the Eaton fire), likely due to stronger sea-breeze ventilation. However, mean NR-PM_1 concentrations were around three times higher when air masses originated from burned areas in the Pacific Palisades compared to those on sea-breeze-impacted days. Particulate polycyclic aromatic hydrocarbons (PAHs), commonly associated with fire ash, increased five times, reaching a mean concentration of 0.11 μg m^{-3} under burned-area-influenced air masses in the Pacific Palisades. Organic aerosol (OA) source apportionment using positive matrix factorization (PMF) further indicated a twofold increase in WUI-wildfire-related nitrogen-containing organic aerosol (NOA). In May, NR-PM_1 concentrations were higher than in February due to elevated sulfate, but showed less spatial variability.

We also conducted indoor/outdoor measurements in three houses with different levels of fire impact. In February, NOA concentrations were higher indoors. In May, NOA was not observed indoors; However, OA concentrations related to house cleaning were higher indoors than outdoors.

In summary, postfire debris can act as potential aerosol emission sources and impacts on indoor and outdoor air quality were observed in February. By May, aerosol loading and composition had largely returned to typical Los Angeles urban patterns.

8WF.5 – INVITED

Wildland Urban Interface (WUI) Fire Smoke: Health Risks and Public Health Protection. JASON SACKS, *U.S. Environmental Protection Agency*

Over the past several decades, both acreage burned from wildfire and the percentage of homes and communities residing in the wildland urban interface (WUI) have increased. Accompanying this increase, there have been more instances of wildfire entering the WUI in recent years (e.g., Marshall Fire, Maui Fire, and LA Fire), resulting in the burning of not only biomass but a vast array of human-made structures and materials. The smoke emitted from a WUI fire is highly complex and contains numerous components not traditionally found in smoke. As a result, WUI smoke exposures are leading to unique risk communication and public health protection challenges. This presentation will focus on characterizing the current state-of-the-science with respect to the health effects associated with WUI fire smoke exposure within the broader context of wildfire smoke and health. It will also highlight the challenges in examining the health risks of WUI fire smoke, including the unique WUI smoke exposure patterns and smoke composition. The presentation will examine how our understanding of the health risks of WUI smoke exposure, along with addressing identified research gaps, can better inform risk communication and the development of targeted interventions to protect public health during WUI fire events.

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8WF.6 – INVITED

The L.A. Fire HEALTH Study: Characterizing Environmental Exposures and Health Effects from Wildland–Urban Interface Fires. KARI NADEAU, *University of California, Los Angeles*

Wildfires in urban areas present unique hazards as buildings, cars, and products are incinerated, exposing people to particulate matter, gases, chemicals, heavy metals, asbestos, Per- and polyfluoroalkyl substances (PFAS), microplastics, and other toxic pollutants. They settle out of the air into soil and dust and can become resuspended during recovery and rebuilding efforts. Water quality can also be affected. The Los Angeles Fire Human Exposure and Long-Term Health Study (L.A. Fire HEALTH Study) was initiated in the aftermath of the 2025 wildfires in Los Angeles County which brought devastating loss of life, homes, schools, businesses, communities, and mountain landscapes. The study is a multi-institutional collaboration led by researchers from Cedars-Sinai; Harvard T.H. Chan School of Public Health; the Keck School of Medicine of USC; Stanford University; University of California, Los Angeles (David Geffen School of Medicine, Fielding School of Public Health, and UCLA Health); University of California, Davis; University of California, Irvine; University of Texas at Austin; and Yale University, with expertise in environmental exposure assessment, health outcomes, wildfire risk assessment and management, and data science. The study has two primary objectives: First to examine which pollutants are present, at what levels, where, and how they change over time; and second to determine the short- and long-term health effects of wildfire smoke exposure in the affected area. The study will determine the composition of pollutants in the wildfire smoke, which including emissions from the burning of vegetation and buildings as well as that of indoor and outdoor air, drinking water, house dust, and soil samples in and near homes. Ongoing research is exploring the health outcomes for people who experienced different levels of smoke and toxin exposure. Several papers have been published, and data will be presented on our exposures and health outcomes findings to date. https://lafirehealth.org/

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9AC.1

Effects of Varying Ozone and Relative Humidity on α-Pinene New Particle Formation. ADAM BUDZYN, Giuseppe Petrucci, *University of Vermont*

New particle formation (NPF) resulting in secondary organic aerosol (SOA) generation from gas phase oxidation of biogenic volatile organic compounds (BVOCs) is still a field of high interest as many questions remain unanswered. One such question is the effect of relative humidity (RH) on NPF. Recent reports have shown conflicting results with either a suppression or enhancement in particle formation using various chemical systems. Many studies use either anomalously high BVOC or oxidant levels, or both, that are not representative of the atmosphere. Herein, we demonstrate that varying the ozone level in experiments with a constant BVOC concentration can result in both enhancement and suppression of NPF rates based on the ozone concentration.

In chamber experiments with α-Pinene (4 ppbv), we show that systematically lowering the ozone level from 200 ppbv down to 25 ppbv has a dramatic effect on NPF enhancement under humid conditions. Enhancements in NPF rate can be seen at higher ozone levels, >500 ppbv, with a 3.5 times enhancement, but at lower levels, <200 ppbv, we observe either no enhancement or indeed a depression in NPF under humid conditions with a 1.5 times enhancement for NPF rate for dry conditions. For ozone levels below about 200 ppbv, initial results suggest a linear trend under humid conditions between NPF rate and ozone mixing ratio, whereas under dry conditions NPF rate increases exponentially with increasing ozone level. However, higher ozone levels (>200 ppbv for these experiments) result in suppression of NPF under dry conditions, possibly due to oxidative degradation of BVOC gas phase oxidation products, which could otherwise contribute to NPF. Under humid conditions however, water may stabilize nascent clusters leading to an NPF enhancement that offsets degradative losses of condensable oxidation products observed under dry conditions.

9AC.2

Effect of Ammonium Salt Counter Ion on Product Diversity in Reactions with Methylglyoxal. ANDREW BERKE, Yuki Yang, Cecilia Wheeler, Robert Samples, *Smith College*

The diversity of compounds produced in reactions between α-dicarbonyls and an amine can affect the physical and chemical properties of the subsequently produced secondary organic aerosol. These reactions are substantively impacted by the solvent environment within which these reactions take place. Our work seeks to systematically alter this solvent environment by changing the counter ion to the ammonia source within a series of ammonium salts (citrate, carbonate, bicarbonate, phosphate, formate, acetate, and benzoate). We explore the role of the counter ion on the chemical compositions of the products formed and compare and contrast across the salts using Electrospray Ionization Mass Spectrometry (ESI-MS). Results from this work identify differences in available product channels across the salt series as well as differences in product formation kinetics.

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9AC.3

Underappreciated Role of Nitrogen Dioxide in the Production of Highly Oxygenated Organic Molecules and Implications for Aerosol Formation. HAN ZANG, Yue Zhao, Wei Huang, Yuliang Liu, Chenxi Li, Wei Nie, Federico Bianchi, *Shanghai Jiao Tong University*

Nitrogen dioxide (NO_2) plays a critical role in atmospheric oxidation of volatile organic compounds (VOCs) by modulating the oxidation capacity of the atmosphere and governing the chemical fate of reactive intermediates such as acylperoxy radicals (RO_2), which collectively influence the formation of highly oxygenated organic molecules (HOMs) and secondary organic aerosol (SOA) during VOC oxidation. While recent laboratory studies have elucidated HOM formation mechanisms from typical VOC oxidation under controlled NO_2 conditions, the impacts of NO_2 on VOC oxidation and HOM formation in ambient atmospheres remain poorly characterized. Here, we combine high-resolution molecular-level measurements from a Finnish boreal forest and a Chinese megacity with detailed chemical model simulations to unravel the distinct influence of NO_2. We quantify the suppression effect of NO_2 on HOM formation by directly scavenging acyl RO_2 radicals across different environments. Furthermore, we identify the key factors controlling the magnitude of this NO_2-driven effect. This work provides crucial quantitative insights into NO_2-mediated HOM formation mechanisms and highlights their implications for new particle formation and the growth of SOA in both pristine and polluted atmospheres.

9AC.4

Matrix Effects on the Photolytic Aging of Laboratory Generated Secondary Organic Aerosol. ANTHONY JUE, Sergey Nizkorodov, *University of California, Irvine*

Secondary organic aerosol (SOA) compounds are known to undergo aging driven by direct and indirect photolysis processes in the troposphere. This type of aging process is especially well constrained for aqueous extracts of SOA representative of cloud and fog droplets. In contrast, photochemical processes occurring in SOA particles in the absence of aerosol liquid water are less understood. The aqueous-phase and SOA-particle-phase aging conditions present drastically different physical and chemical environments for photochemistry. These differences in the molecular environment can drastically alter photochemical mechanisms because photoexcited SOA compounds primarily interact with other organic molecules in particles, whereas they can interact with water molecules in aqueous droplets. In this investigation, we compare the photolytic aging products of SOA from α-pinene, naphthalene, and other precursors, generated in a smog chamber under photooxidative conditions, and collected on a filter substrate. The aging is carried out in an aqueous solution (to model cloud and fog droplets), in an organic solution (to model non-viscous SOA particles) or on the filter (to model viscous SOA particles). The distribution of products from these processes are then analyzed using UPLC-HRMS to identify common and unique products for all these aging environments. These results will allow us to better constrain molecular mechanisms of SOA photochemical aging processes in the troposphere.

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9AC.5

Implementation and Evaluation of the Updated AMOREv2.1 (Automated MOdel REduction) on a Comprehensive Monoterpene Mechanism. KATHERINE STEVENSON, Forwood Wiser, V. Faye McNeill, *Columbia University*

Full oxidation mechanisms of volatile organic compounds are too computationally costly to be included in large-scale chemical transport and air quality models. The graph theory-based Automated MOdel REduction (AMORE) version 2.1 algorithm simplifies chemical mechanisms, while retaining yield accuracies, to enable their use in 3D models. AMORE employs several graph theory techniques to estimate yields, sort species, group and categorize similar species, and ultimately reduce the size and complexity of oxidation mechanisms. Updates presented in this newest version of AMORE increase the robustness of species grouping and categorization, as well as enhance the representation of peroxyacyl nitrate (PAN) chemistry. Updates have been thoroughly tested through the reduction of a 3-species (α-pinene, β-pinene, and limonene) monoterpene oxidation mechanism. To obtain a comprehensive monoterpene oxidation mechanism, Master Chemical Mechanism v3.3.1's mechanism (Jenkin et al., 1997; Saunders et al., 2003) was supplemented with the Peroxy Radical Autoxidation Mechanism (Roldin et al., 2019). The chemistry of highly oxygenated organic molecules (HOMs), which are important for SOA formation, is protected in the reduced AMORE-monoterpene mechanism via categorization. Due to the highly interconnected nature of these HOM categories, significant updates were required to accurately protect their production and consumption. A sub-algorithm was also created and implemented in AMOREv2.1 to identify and protect PAN reactions upstream of important oxidation products. Resultant reduced AMORE-monoterpene mechanisms are compared with simplified chemistry used in GEOS-Chem and the Community Regional Atmospheric Chemistry Multiphase Mechanism (CRACMM).

9AC.7

Navigating Challenging Areas of Atmospheric Reactivity Space in Environmental Chamber Studies with Direct RO2 Generation. COOPER CRABTREE, Victoria Barber, *University of California, Los Angeles*

Volatile organic compounds are ubiquitous atmospheric pollutants readily oxidized in the troposphere to form alkyl peroxy radicals (RO2). Among the numerous reactions available to RO2, self-reactions (RO2+RO2) and isomerizations tend to form lower volatility products that partition to secondary organic aerosol (SOA), degrading air quality and impacting climate. While important to the atmosphere, this chemistry is difficult to access and study experimentally, as traditional routes to form RO2 in environmental chambers introduce coreactants that limit the importance of isomerization and self-reaction pathways. Thus, RO2 fate remains a major source of uncertainty in atmospheric models, and these understudied pathways are often simplified or omitted from model chemistry altogether. Here, we demonstrate an approach to preferentially access these pathways in an environmental chamber experiment. We photolyze 1-iodopentane to generate the 1-pentyl peroxy radical without an additional oxidant source, drastically simplifying the available RO2 chemistry in our 0.25 m^3 chamber. We conduct a series of chamber experiments to explore changes in RO2 fate over a range of light intensities and starting concentrations of 1-iodopentane. Using ammonium chemical ionization mass spectrometry, we observe products of RO2 isomerizations, self-reactions, and cross-reactions—suggesting RO2 reaction pathways are interacting and RO2 fate is highly variable, even in our simplified system. We also observe different product distributions and formation trends when comparing between experiments, demonstrating our ability to change RO2 fate in our chamber. In all our experiments, the major observed product is formed following an RO2 isomerization and is absent from the Master Chemical Mechanism, a baseline model for canonical atmospheric chemistry. By appending this mechanism with a simplified isomerization scheme, our experimental results are more closely correlated with model outputs, but additional work is needed to improve this agreement. Further experiments performed at longer time scales in a 6.5 m^3 chamber will aim to link these gas-phase RO2 reactions to downstream SOA formation.

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9AC.8

From Laboratory Experiments to Global Modeling: Advancing Understanding of Secondary Organic Aerosol Formation from Anthropogenic and Biogenic Precursors. YANYU ZHANG, William Porter, Maryam Ghadimi, Thomas Eckel, David R. Cocker, *University of California, Riverside*

Secondary organic aerosol (SOA) constitutes a major fraction of atmospheric fine particulate matter and remains one of the largest uncertainties in air quality and climate predictions due to incomplete representation of precursor chemistry and aerosol formation pathways in atmospheric models. To improve understanding of SOA formation from both anthropogenic and biogenic volatile organic compounds, this work integrates more advanced controlled environmental chamber experiments with global chemical transport modeling. Laboratory experiments were conducted under more realistic atmospherically relevant conditions to investigate SOA formation across a range of precursor classes and oxidation environments. The SOA formation framework in the GEOS-Chem chemical transport model was updated beyond the conventional representation based on linear interpolation between two extreme chemical pathways to better capture chemically dependent aerosol formation. Chamber-derived observations were then incorporated to constrain precursor-specific SOA parameterizations and improve representation of aerosol formation under diverse oxidation environments. Model simulations with these updates are applied to examine the atmospheric implications of revised SOA treatments for simulated aerosol distributions and burdens. This integrated laboratory-to-modeling framework provides a pathway for translating mechanistic chamber observations into atmospheric-scale predictions and highlights the importance of coupling experimental and modeling approaches to reduce uncertainties in SOA representation.

9AC.9

Chemical Transformations of Pesticides in Aerosols Produced from Cannabis Vaping. DALIA CRUZ CARBAJAL, Nikolas Castanon, Rhianna Evans, Tran Nguyen, *University of California, Davis*

Cannabis vaping refers to using cannabis specific electronic cigarettes to produce and inhale aerosols composed of concentrated cannabinoid (e.g., Δ9-THC) distillates, oils, or waxes mixed with other synthetic and natural compounds. In the United States, cannabis users are increasingly favoring vaping over traditional smoking, leading to a critical blind spot in public health understanding as the aerosols from cannabis vaping are severely understudied. Beyond cannabinoids, pesticides exceeding legal regulatory limits have been identified in cannabis electronic cigarettes due to the use of pesticides in the cultivation of marijuana that become concentrated with the psychoactive ingredients during the extraction process. Yet, there is a lack of understanding of how these compounds may be transformed during the vaping process leading to a concern for health implications. We aim to determine the dose transfer of pesticides from vape oil to inhaled aerosol and identify if they degrade into more toxic products. Six pesticides commonly found in vaping fluids were spiked into distillates of Δ9-THC and vaped using an authentic cannabis vaping device. The chemical composition of vaped and unvaped pesticide distillate mixtures will be compared to understand the chemical transformations that occur during the vaping process. Gas Chromatography Mass Spectrometry (GC-MS) was used to identify and quantify pesticides, cannabinoids, and other chemical components present. This work will further the understanding of the health risks and effects of cannabis vaping on public health.

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9AC.10

Secondary Organic Aerosol from Chlorine-Initiated Oxidation of Citronellal Under Indoor and Outdoor Lighting Conditions.
LEA EL KHOURY, Lea Hildebrandt Ruiz, *University of Texas at Austin*

Citronellal is a main component of citronellal oil and a common ingredient in insect repellents and personal care products. Here we investigate SOA formation from the oxidation of citronellal initiated by chlorine radicals, hydroxyl radical, or ozone, under lighting conditions representative of indoor and outdoor environments. Environmental chamber experiments were conducted across a range of relative humidity (RH) (<1%-40%), temperature (10-40 °C), and lighting conditions (LED and UV). Non-refractory particulate matter (NR-PM) was measured using a High-Resolution Time-of-Flight Aerosol Mass Spectrometer (HR-ToF-AMS) and a Scanning Electrical Mobility Spectrometer (SEMS), while gas-phase citronellal decay was monitored using gas chromatography. SOA formation from Cl-initiated oxidation of citronellal is high with aerosol mass yields exceeding 1 in most experiments. Aerosol mass yields depend on environmental conditions, with lower organic aerosol mass yields at higher RH and higher yields at lower temperatures. Overall, the oxidation of citronellal contributions to SOA loadings in indoor and outdoor air and thereby impact human health.

9AC.11

Intermolecular Interactions Between Methoxyphenols and Quinones: Implications for Brown Carbon from Bulk Solutions to Levitated Droplets.
AHMADRAZA CHAUDHARY, Colton Calvert, Holly Anthony, Micah Miles, Elijah Schnitzler, *Oklahoma State University*

Biomass burning is a significant source of organic aerosol in the atmosphere, including light-absorbing components classified as brown carbon (BrC). These aerosol particles absorb sunlight in the near-UV and visible regions and therefore influence Earth's radiative balance. The light-absorbing properties of BrC can change due to multiphase interactions in the atmosphere. Methoxyphenols, such as guaiacol, are important precursors for BrC formation and are among the most common phenolic compounds emitted from biomass burning. Although methoxyphenols themselves are generally colorless liquids or crystalline solids that do not absorb strongly in the visible region, their interactions with other atmospheric compounds may enhance their absorption. Previous work has shown that interactions between guaiacol and quinones (i.e., benzoquinone and naphthoquinone) lead to enhanced absorption through charge-transfer (CT) complexes in bulk solutions and thin films. In this work, we expanded on this precedent by investigating additional electron donor species in bulk and thin-film experiments and by probing these interactions in levitated droplet experiments. In the acoustic levitator experiments, droplets of donor species were suspended and exposed to varying mixing ratios of gas-phase benzoquinone, and visible spectroscopy was used to monitor changes in absorbance through uptake. Upon exposure to benzoquinone, initially colorless droplets rapidly became strongly absorbing, consistent with CT complex formation. After exposure, the system was flushed with nitrogen, resulting in decreased absorbance and indicating that the interaction is reversible. The decay in absorbance was slower than the rate of dilution, consistent with strong intermolecular interactions in the droplet, with a large associated effective Gibbs energy of partitioning. NMR spectroscopy showed no evidence of new covalent products, supporting the formation of non-covalent intermolecular complexes. These results suggest that non-covalent multiphase interactions between methoxyphenols and quinones may contribute to the light absorption and climate impacts of BrC.

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9AC.12

Practical Approach to Improved Temperature Dependence of Vapor Pressure in Modelled Partitioning of Biomass Burning Organic Aerosol. Sithumi Liyanage, Madiha Mazhar, Christian Escritt, ELIJAH SCHNITZLER, *Oklahoma State University*

After emission, biomass burning organic aerosol (BBOA) is transported vertically, often to high altitudes. As temperature decreases with altitude, this vertical transport will significantly alter the gas-particle partitioning of BBOA components, dictated by volatility, expressed in terms of vapor pressure or saturation mass concentration. While the temperature dependence of vapor pressure is treated at a sophisticated level (usually with multiple empirical parameters) in many estimation methods, it is still most convenient in chemical transport models to implement an estimated vapor pressure at one reference temperature and an estimated enthalpy of vaporization, ΔH_{vap}, in the Clausius-Clapeyron relationship to obtain the vapor pressure for other temperatures during transport. Here, we investigate the implications of this common practice by exploring the curvature of vapor pressure versus temperature data in the literature. We find that for all oxygenated organics, including known components of BBOA, the curvature is positive, corresponding to fitted values of −25 to −150 J K^{-1} mol^{-1} for the heat capacity difference between the gas and condensed phases, ΔC_p. Consequently, actual volatility decreases faster upon cooling during upward transport than is predicted by the Clausius-Clapeyron relationship, i.e., neglecting ΔC_p. Even for moderate curvature, the vapor pressure at 240 K with ΔC_p is about 0.7 of that with only ΔH_{vap}. Since the vapor pressures are over-estimated with only ΔH_{vap} for all BBOA components, this may translate to a systematic under-estimation of BBOA mass. We propose a practical approach to correcting Clausius-Clapeyron-estimated vapor pressures by incorporating ΔC_p, a single new parameter, with the added advantage that it has a physical rather than strictly empirical basis.

9AC.13

Contrasting Impacts of Long-Range Transported Wildfire Smoke and Regional Combustion Plumes on Biogenic Organosulfate Chemistry in a Forest Environment. SINING NIU, Gregory W. Vandergrift, Meghan C. Guagenti, Nurun Nahar Lata, Zezhen Cheng, Ashfiqur Rahman, Jing Li, Swarup China, *Pacific Northwest National Laboratory*

Atmospheric aerosols play important roles in air quality, earth system, and cloud formation, yet the molecular processes controlling their evolution under mixed biogenic and combustion influence remain incompletely understood. Among the molecular constituents of biogenic secondary organic aerosol (SOA), organosulfates (OS) are particularly relevant as they can reflect multiphase chemistry and changes in oxidative environment. In this study, we investigated plume-dependent changes in biogenic OS chemistry at Bankhead National Forest in Alabama using offline nano-DESI Orbitrap high-resolution mass spectrometry integrated with collocated measurements of aerosol composition, combustion tracers, and meteorological conditions. Two distinct combustion-influenced episodes were identified: an aged long-range wildfire plume associated with a more processed environment, and a fresher regional combustion plume with less oxidative processing. Although both enhanced combustion tracers, they produced different molecular OS responses. During the wildfire period, the intensity and detected molecular formulas of nitrogen containing organic species (CHON) increased whereas sulfate containing organic species (CHOS) compounds decreased, accompanied by higher oxidation state and an increased 2-methylglyceric acid organosulfate to 2-methyltetrol organosulfate ratio, indicating a shift in isoprene-derived OS chemistry from low NOx to high NOx scheme. In contrast, the regional plume was characterized mainly by mixing with more reduced organic aerosols and showed limited changes in OS pathway. Clustering analysis further showed that wildfire smoke suppressed fresh biogenic OS formation while enhancing the presence of more aged OS families in the forest region. These results demonstrate that combustion impacts on forest SOA depend strongly on plume processing history and oxidative context, providing molecular-level constraints for representing wildfire–biogenic interactions in atmospheric models.

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9AC.14

Photolysis-Driven Aging of Smoke Film on Urban Surfaces and Wash-Off Effects. JANIE (YEASEUL) KIM, Willow Hwang, Manjula Canagaratna, Benjamin A. Nault, Anita Avery, Mitchell Alton, Lisa Azzarello, Christopher Cappa, Cora Young, Rachel O'Brien, *University of Michigan*

In wildfire-affected urban areas, impervious surfaces such as windows and building walls become coated with complex smoke-derived organic films. Exposed to sunlight and periodic rainfall, these films can undergo physicochemical transformations that may affect the longer-term fate of smoke contaminants in urban environments. Yet how the underlying surface mediates photolysis-driven aging and subsequent rain-driven removal remains poorly understood.

We investigated the photolysis-driven aging of pinewood smoke films deposited on two urban-relevant surfaces: glass (proxy for windows) and anatase titanium dioxide (TiO_2, proxy for painted walls). Films were characterized before and after photolysis using offline Aerosol Mass Spectrometry (AMS), Electrospray Ionization High-Resolution Mass Spectrometry (ESI-HRMS) in negative mode, and Size-Exclusion Chromatography with UV detection (SEC-UV). These measurements suggested that the underlying surface influences photolytic transformation pathways: glass surfaces promoted formation of higher-molecular-weight, more oxidized, lower-volatility products, whereas aging on the TiO_2 surface was associated with products of slightly higher overall volatility. Notably, large light-absorbing chromophores were observed on both surfaces regardless of surface type.

These photolysis-driven compositional changes may in turn influence how smoke films respond to rainfall. To explore this, we further examine wash-off effects on both surfaces before and after photolysis using MilliQ water as a rain proxy. Offline AMS characterizes film composition prior to washing and tracks compositional shifts across washable and residual fractions. Residual film chemistry at the nanoscale is further probed by Atomic Force Microscopy-Infrared Spectroscopy (AFM-IR).

Together, these results can offer insight into how surface characteristics shape the environmental fate of wildfire smoke films, with relevance for urban remediation strategies and water quality following wildfire events.

9AC.15

Formation and Photolysis of Wildfire-Related Organonitrates in Mixed VOC Systems. JIANHUAI YE, Chen Zhang, *Southern University of Science and Technology*

Wildfires emit substantial amounts of volatile organic compounds (VOCs), which significantly affect local and regional air quality and human health. During the nighttime, these VOCs can be oxidized by nitrate radicals to form organonitrates (ONs), which have traditionally been considered a stable sink for reactive nitrogen in the atmosphere. However, growing evidence suggests that highly oxidized ONs are less stable than previously thought. Furthermore, interactions among VOCs within wildfire plumes add further complexity, altering the physicochemical properties of the resulting ONs. In this study, we investigated representative aromatic VOCs emitted from wildfires (i.e., styrene), alongside limonene as a representative biogenic VOC that may be co-emitted. We found that aromatic ONs formed from the dark oxidation of styrene exhibit enhanced light absorption upon photolysis. Box model simulations incorporating updated chemical mechanisms reveal that different VOC mixtures and VOC-to-oxidant ratios can substantially modify ON light absorption, successfully reproducing laboratory observations. These findings suggest that photolysis-induced photo-enhancement represents a significant yet overlooked atmospheric aging process for aromatic ONs.

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9AC.16

In Situ Characterization of Trace Gas and Aerosol Emissions from Prescribed Burns in North Florida. MANISHA MEHRA, Amir Reza Sharafuddin, Ruoyu Zhang, Chanakya Bagya Ramesh, Sujan Shrestha, Holly Nowell, Hannah Schley, Siyuan Wang, Yang Wang, *University of Miami*

Prescribed burning is widely used across the southeastern United States (U.S.) for ecosystem management and to reduce the risk of catastrophic wildfires. Florida leads the nation in prescribed fire activity, with more than 2 million acres burned annually across pine flatwoods, grasslands, and sawgrass ecosystems (Florida Forest Service, 2023). While ecologically beneficial, these fires emit substantial amounts of trace gases and aerosols that influence regional air quality, cloud formation, and radiative forcing (Akagi et al., 2011; Urbanski, 2014). Although prescribed fire emissions have been studied in parts of the southeastern U.S., observations from North Florida remain limited. Prior work in Florida has focused largely on agricultural burning, particularly pre-harvest sugarcane fires in southern Florida, which elevate particulate matter and trace gas concentrations. In contrast, emissions from ecosystem-management burns in sawgrass and pine–oak systems remain poorly constrained. Here, we present in situ measurements of trace gases and aerosols collected during prescribed burns near Tallahassee, Florida. Real-time CO, CO_2, and NOx (NO + NO2) were measured using a portable gas analyzer, while aerosol particle number and mass size distributions were measured using a Scanning Mobility Particle Sizer (SMPS). During the burning period, the mass concentration of Aitken-mode particles increased from 0.22 to 102 μg m^{-3}, while accumulation-mode particle mass increased from 3.2 to 561 μg m^{-3}. The calculated modified combustion efficiency (MCE) remained consistently above 95%, indicating predominantly flaming combustion overall, likely reflecting efficient burning of relatively dry fuels under managed prescribed-fire conditions, despite the co-occurrence of localized smoldering. Using a carbon mass-balance approach, we calculated emission factors (EFs) for NOx and Aitken- and accumulation-mode particles. The EF for NOx was 1.2 g kg^{-1}, consistent with values reported in previous prescribed-burn studies (Travis et al., 2023), while the EFs for Aitken and accumulation-mode particles were 0.03 and 0.17 g kg^{-1}, respectively. Additional metagenomic sequencing is being conducted to analyze the biological properties of the collected aerosols. These observations provide needed constraints on trace gas and aerosol emissions from the prescribed burns and improve understanding of prescribed-fire impacts on regional air quality and smoke emissions.

9AC.17

Exploring the Influence of Particle Properties on the Complex Refractive Index of BrC-Containing Aerosol. KATELYN PACAUD, Malsha Amugoda, Pedro De Allende, James F. Davies, *University of California, Riverside*

Aerosol particles in the atmosphere scatter and absorb light, influencing the Earth's energy balance and climate. The extent of light scattering and absorption for a given particle can be quantified by its complex refractive index (m=n+ik), where the real-part (n) defines scattering and the imaginary part (k) defines absorption. With increasing rates of wildfires, brown carbon (BrC) compounds have grown increasingly relevant to the optical impact of aerosols in the atmosphere. BrC chromophores absorb light in the 300-400 nm range and are emitted primarily via fossil fuel combustion and biomass burning. However, current climate models struggle to accurately determine the impacts of BrC. BrC chromophores have a strong wavelength-dependent absorbance that changes dynamically with environmental and physicochemical factors, including relative humidity (RH), pH, volatility, and molecular structure. Here, we use a linear quadrupole electrodynamic balance for single-particle levitation coupled with LED illumination to probe n and k of trapped particles. These measurements allow particles to be sampled in supersaturated state, providing absorption measurements that are more comparable to concentrations in atmospheric particles than bulk UV-vis measurements. Specifically, we show the effects of RH and particle pH, revealing strong shifts in absorbance with protonation state for a range of soluble BrC chromophores. We further explore the influence of surface adsorption on chromophore activity via a direct comparison between bulk and surface-active chromophores. Overall, these findings will help us to better understand and predict the influence of BrC-containing aerosol particles in the atmosphere.

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9AC.18

Determination of Channel-Specific Unimolecular Reaction Rate Coefficients of Peroxy Radicals Formed from the OH-Initiated Oxidation of α-Pinene. QINGWEN TAO, Jonathan Varelas, John Crounse, Paul Wennberg, Franz Geiger, Regan Thomson, Lu Xu, *Washington University in St. Louis*

Unimolecular reactions of organic peroxy radicals (RO_2) play an important role in the atmospheric oxidation of volatile organic compounds (VOCs). When followed by O_2 addition, these reactions can initiate autoxidation sequences that form highly oxygenated organic molecules (HOMs) and other low-volatility products, which contribute to secondary organic aerosol (SOA) formation and particle growth. However, experimental constraints on RO_2 unimolecular reaction kinetics remain limited. Ring-opened RO_2 formed in the OH-initiated oxidation of α-pinene undergoes rapid unimolecular reactions, including 1,5 H-shift, 1,6 H-shift, and endo-cyclization. Previous measurements have constrained only the overall unimolecular loss rate of the ring-opened RO_2 and did not resolve branching among chemically distinct channels. Because these channels form structurally different radicals with different potential for further O_2 addition and low-volatility product formation, channel-specific rate coefficients are needed to predict oxidation product distributions under varying atmospheric conditions. In this study, we use site-specific deuterated α-pinene isotopologues to suppress selected H-shift channels and separate the contributions of competing unimolecular reactions. The overall unimolecular rate coefficient for the ring-opened RO_2 from each deuterated isotopologue was measured at 296 K using a hydroxy nitrate (HN)-based kinetic approach and compared with that of unlabeled α-pinene to obtain channel-specific rate coefficients. This analysis shows that endo-cyclization dominates the total unimolecular loss, while the 1,5 and 1,6 H-shift channels are slower and comparable in magnitude. The derived rate coefficients are broadly consistent with theoretical calculations and provide direct experimental constraints on individual unimolecular channels of α-pinene-derived RO_2. The channel-specific rate coefficients offer a quantitative basis for predicting oxidation product distributions under different atmospheric conditions and serve as experimental benchmarks for density functional theory (DFT)-based kinetic calculations and structure–activity relationships (SARs) for RO_2 unimolecular chemistry.

9AC.19

Using Partitioning Models to Investigate the Apparent Surface PKa Values of Medium Chain Fatty Acids. REBIKA TAMANG, Jacob Twichell, Michael Jacobs, *Texas State University*

The chemical composition and acidity of the air-water interface are important to describe chemistry in microdroplets and aerosol particles. For example, medium chain fatty acids are surface active compounds typically found in ambient aerosol particles whose behavior at the air water interface can differ from that in bulk solution. This study investigates how adsorption and surface partitioning influence apparent surface pKa behavior of fatty acids with varying carbon chain lengths. A Krüss force tensiometer was used to measure surface tension of buffered solutions of hexanoic, octanoic, nonanoic and decanoic acid over the pH range from 2 to 9. Aliquots of fatty acids were gradually added to each buffer solution to examine concentration dependence on adsorption at air water interface. The difference in surface tension values obtained at various pH levels and for different chain lengths of fatty acids indicates that substantial differences in surface activity of fatty acids occur due to the protonation state. A partitioning model was developed to consider competitive adsorption of protonated and deprotonated fatty acids for the air-water interface. This partitioning model successfully captures the trend of increasing apparent surface pKa values with increasing fatty acid concentration. These findings suggest differences in surface partitioning of protonated and deprotonated forms may account for differences in apparent surface pKa values, rather than solely reflecting on fundamental acid base chemistry.

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9AC.20

Coupled Condensational Growth and Colorimetric Analysis for Aerosol pH Measurement of Atmospherically Relevant Systems. SOPHIE BAZYDOLA, Cara Waters, Mia Kauffman, Anthony Rovinski, Andrew P. Ault, *University of Michigan*

Aerosol pH is an important property to quantify due to its influences on heterogeneous chemistry, particle phase state, hygroscopicity, and other physicochemical characteristics. Both inorganic and organic species participate in determining aerosol pH, each with different volatilities and acidities, leading to a highly complex system to understand, model, and predict. In the ambient atmosphere, aerosols have been shown to be generally acidic, with pH values spanning up to five units. Currently, aerosol acidity is typically estimated using thermodynamic model predictions, with fewer than 100 direct measurements made globally. Particle acidity is difficult to measure due to high ionic strengths, low aerosol liquid water content (ALWC) in low relative humidity regions, and the non-conservative nature of the hydronium ion, highlighting the need for new approaches to measure this property. One such method is condensational growth coupled with colorimetric measurement for determining aerosol pH, a newly established technique that overcomes limitations for highly acidic and/or low ALWC particles. However, this method has only been established for sulfate-rich aerosol populations, which have different equilibrium considerations than other atmospherically relevant systems. Herein, we extend this method to other atmospherically relevant aerosol systems, such as acidified sodium chloride and ammonium nitrate aerosols. Particles generated from bulk solutions of different pH were passed through a condensational growth tube (Spot Sampler, Aerosol Devices) where they grew to ~4.8 µm droplets and were then impacted onto pH indicator paper. The colorimetric droplet pH was then used to determine the original aerosol pH through volumetric water uptake corrections. Experimentally determined pH values were also compared to calculations using model outputs from the Extended Aerosol Inorganics Model (E-AIM). This study extends our pH measurement technique to more diverse aerosol populations, enabling future studies to expand our understanding of aerosol acidity to new environments.

9AC.21

Measuring How Surface Partitioning of Alkyl Acids Influences Bulk Microdroplet pH. WILLIAM DEAN, Michael Jacobs, *Texas State University*

The chemistry in microdroplets is often distinct from that in macroscale solutions due to their large exposed surface areas. Chemical reactivity at the air-water interface differs significantly from that in bulk solution. As a result, microdroplet reactivity and physicochemical properties are expected to be strongly influenced by surface reactivity. For example, the acidity of the air-water interface is thought to catalyze reactions in microdroplets, but this is actively debated. Protonatable molecules are expected to have shifted pKa values at the surface compared to bulk solution, with neutrally charged species being more stable at the surface than changed species (i.e., surface pKa of acids is expected to be larger than bulk solution pKa). Thus, in microdroplets and aerosol particles molecular partitioning to the air-water interface is expected to change bulk microdroplet pH. In this work, a pH-sensitive fluorescent dye (pyranine) is used to explore how bulk microdroplet pH changes as a result of surface partitioning of alkyl acids. Fluorescence intensities of buffered droplets containing pyranine were used to prepare calibration curves that enabled *in situ* measurement of droplet pH. Then, the pH of unbuffered droplets both with and without small concentrations of alkyl acids (e.g., decanoic acid) with varied surface activity were measured. Differences in pH between the alkyl-acid-containing and unmodified droplets are interpreted using a simple kinetic model to simulate acid-base chemistry and partitioning effects. In general, experimental results demonstrate that surface partitioning and larger surface pKa values can increase the bulk microdroplet pH. Ultimately, these results explicitly demonstrate how bulk microdroplet properties can be controlled by surface chemistry.

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9AC.22

Surface Tension Shifts in Hanging Droplet Exposed to Organic Gas Concentration Step Changes. TSERING YOUDON, Michael Haines, Joseph Woo, *Lafayette College*

When exposed to changes in ambient concentrations of gas-phase VOCs, atmospheric aerosols will necessarily exhibit partitioning of those compounds into and out of its condensed phase. The uptake of surfactant VOCs into aerosols are of particular interest, as the accumulation of surface-active compounds can also change the prevailing surface tension of the droplets that they occupy, in turn affecting their ability to activate into cloud droplets in supersaturated conditions. The rate and extent to which surface tension of droplets exposed to VOCs change will be dependent on the composition and concentration of both the droplets and the gases that are partitioning. This work explores this phenomenon by exposing hanging droplets of water, ammonium sulfate, ammonium nitrate, and glycerol solutions to step-change gas concentrations of two VOCs (ethanol and methylglyoxal.) Time-resolved surface tension measurements are reported, along with fitted first-order time constants representative of the rate in which steady state surface tensions under different ambient conditions are achieved.

9AC.23

Halogen Activation by Photosensitized Processes in Atmospheric Aerosol Particles. ELEANOR MIKO, Sergey Nizkorodov, *University of California, Irvine*

Secondary organic aerosols (SOA) are formed by the photochemical oxidation of primary organic matter and volatile organic compounds (VOCs) in the atmosphere and represent a major fraction of global atmospheric organic aerosols. One particularly uncertain aspect of atmospheric aerosol chemistry is the role of photosensitized processes. In aerosol particles, these processes have been proposed to form halogen atoms and radical ions, which are highly reactive and important oxidizers of both organic and inorganic tropospheric compounds. These products may additionally lead to the formation of halogenated compounds with further implications for tropospheric and stratospheric chemistry. While it is known that some SOA compounds act as photosensitizers, their efficiency in photooxidation of halogen ions has not been investigated, and further research is necessary to develop a more detailed understanding of the mechanisms for photosensitized production of halogen atoms, radical ions, and other halogenated products. To estimate the maximum effect of photosensitized halogen activation, we irradiated mixtures of 4-benzoylbenzoic acid (4BBA), a known photosensitizer, and potassium iodide. In the next set of experiments, we replaced 4BBA with an equivalent amount of SOA produced from the photochemical oxidation of two distinct types of VOCs: (1) SOA produced by ozonolysis of limonene, representative of forest environments and (2) SOA from naphthalene, representative of heavily polluted urban air. In addition to these SOA, an aqueous condensate of wood combustion emissions (liquid smoke) was also examined. Ultra-High Performance Liquid Chromatography High-Resolution Mass Spectrometry (UHPLC-HRMS) and Ultraviolet-Visible (UV-Vis) spectroscopy were utilized for analysis. With this approach, we could rank the efficiency of photosensitized halogen activation by different types of organic aerosols.

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9AC.24

Heterogenous Nitration and Oligomerization Reaction of BSA Protein with Urban Air. RILEY SMITH, Sadie Morley, Alex Volkova, Rachel Davey, Erick Mattson, J. Alex Huffman, *University of Denver*

Proteins are found in the aerosol phase primarily as a component of biological particles such as pollen or spores. While proteins can promote allergenic effects directly, they can also undergo heterogeneous reactions to promote post-translational modification, increasing their allergenicity. A heterogeneous reaction mechanism driven by gas-phase ozone (O3) and nitrogen dioxide (NO2) has been shown to promote both nitration and oligomerization of exposed tyrosine residues within analyzed proteins. Nitrated tyrosine has been shown to produce an increased IgE response in rat models, thus suggesting proteins embedded in pollen could become more allergenic when exposed to urban air pollution. BSA (bovine serum albumin) was used as the model protein and loaded onto syringe filters to be exposed to a constant flow of ambient air. Samples were placed at the Rocky Flats North and La Casa air monitoring sites operated by the Colorado Department of Public Health and the Environment (CDPHE) in the Denver metropolitan area. After 2-4 weeks of exposure, each BSA sample was extracted from the filters using a phosphate buffer solution (PBS) flush and analyzed via high-performance liquid chromatography (HPLC), comparing peaks produced at wavelengths of 280 nm (unmodified protein detection) and 357 nm (nitrated protein detection) to determine nitration degree (ND).
Previous work from our group showed the relative ratio for oligomerization to nitration increased when exposure increased, but only a small population was available for that initial set of observations. This study attempted to illustrate previously suggested patterns. Overall, samples exhibited slight peaking and decreasing nitration over time with significantly lower ND. To gain greater confidence in the observed pattern, additional investigation is needed into the changes in flow rate and BSA degradation over time.

9AC.25

Optical Properties and Radiative Effects of UTLS Aerosols Constrained by Chemical Imaging. YAOWEI LI, Steven Sharpe, John Dykema, Xiaoli Shen, Felipe Rivera-Adorno, Daniel Cziczo, Alexander Laskin, Frank Keutsch, *California Institute of Technology*

The upper troposphere and lower stratosphere (UTLS) is a critical region for aerosol-chemistry-climate interactions, where dynamics, chemistry, clouds, aerosols, and radiation are intricately connected. Aerosols in the UTLS influence the global energy balance through both scattering and absorption of radiation, as well as by modifying ice cloud lifecycles. Their radiative effects depend strongly on morphological properties (e.g., size, shape, and mixing state) and chemical composition, yet key uncertainties remain, particularly for carbonaceous components.

The Dynamics and Chemistry of the Summer Stratosphere (DCOTSS) airborne mission provided an opportunity to characterize UTLS aerosols over North America in the summers of 2021 and 2022. Using the NASA ER-2 high-altitude aircraft, aerosol size distributions between 0.14-2.5 µm diameter were measured in situ by an optical particle spectrometer, and chemical composition was characterized by single particle mass spectrometry. Additionally, aerosol samples in different size ranges (0.3-3.2 µm diameter) were collected using a cascade impactor and analysed with offline chemical imaging techniques. Offline analysis revealed the morphological and chemical complexity of stratospheric aerosol, showing internal mixing of elemental carbon, abundant organic carbon, and inorganic material, consistent with online measurements. Specifically, the mixing state of different components, organic volume fraction, and carbon functional groups in individual particles were determined using Scanning Transmission X-ray Microscopy (STXM) coupled with Near Edge X-ray Absorption Fine Structure Spectroscopy (NEXAFS). These detailed constraints on aerosol morphology and composition were used to derive bulk refractive indices via group contribution methods. The resulting optical properties were then incorporated into a radiative transfer model to quantify their radiative effects and associated uncertainties. This work provides new observational constraints on the optical properties of UTLS aerosols and highlights the importance of particle-level chemical and morphological information for improving estimates of aerosol radiative effects.

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9AC.26

Assessment of Isoprene Epoxydiol Reactive Uptake Onto Acidic Sulfate Aerosols by Real-Time Isomer Characterization. MATTHIEU RIVA, Yuzhi Chen, ManishKumar Shrivastava, Peter Mettke, Molly Frauenheim, Rebecca L. Rice, Brian Gaudet, Jason Surratt, Megan Claflin, Harald Stark, Vasyl Yatsyna, Stephan Graf, Urs Rohner, Laurent Poulain, Hartmut Herrmann, Sebastian Gerber, Felipe Lopez-Hilfiker, Avram Gold, Michael Kamrath, *CNRS-IRCELYON*

Isoprene epoxydiols (IEPOX) are key precursors of secondary organic aerosol (SOA) in isoprene-rich regions, yet uncertainties remain in their multiphase chemistry and gas–particle partitioning dynamics. Conventional online mass spectrometry cannot disentangle the structural isomers generated during IEPOX reactive uptake, limiting the mechanistic understanding needed to improve atmospheric models.

To address this gap, we performed atmospheric simulation chamber experiments on the reactive uptake of IEPOX onto acidic sulfate aerosols, using a chemical ionization source coupled to a low-pressure ion mobility spectrometer. The instrument provides high-resolution, real-time isomer separation without prior sample preparation, enabling direct monitoring of dynamic isomer populations as the reactive uptake proceeds.

The measurements reveal substantial acid-driven particle-phase IEPOX isomerization, yielding 3-methylenebutane-1,2,4-triol and 3-methyltetrahydrofuran-2,4-diol isomers that predominantly partition back to the gas phase, where they can undergo further oxidation and contribute to SOA. Coupling these isomer-resolved observations with a zero-dimensional chemical kinetic box model allowed us to constrain reaction rate constants and volatilities of the major non-sulfated IEPOX-derived products. Experimentally derived volatilities are substantially higher than in previous parameterizations, implying greater partitioning to the gas phase than currently assumed.

Incorporating the updated rate constants and volatility estimates into WRF-Chem reduces simulated IEPOX-derived SOA burdens by up to 60 % in the Amazon Basin and up to 20 % in the southeastern United States. Overall, this work provides a more physically and chemically consistent framework for predicting isoprene-derived SOA, with implications for both air quality and climate projections.

9AD.2

How Many Dust Storms Occurred Across the Western United States over the Last 20 Years? KARIN ARDON-DRYER, Felicia Dogbey, Kelsey Olson, Cade Hogle, Ally Brawner, *Texas Tech University*

Dust events impact millions of people across the US and are an important and complex constituent of the atmospheric system. They are one of the main natural contributors to atmospheric aerosol. Atmospheric dust particles affect the climate, environment, air quality, economy, and human well-being and health. Dust storms are the most severe form of dust events, defined by horizontal visibility ≤ 1 km. However, the number of dust storms that have occurred across the western US states over the last 20 years (2000-2020) remains uncertain. Using ground meteorological measurements, we were able to identify times with dust storms. Our results will show the number of dust storms that occurred across the western US over the last 20 years (2000-2020), including when they occur, and how long they last. The impact of these dust storms on aerosol concentrations and particle sizes will be highlighted in specific locations when measurements are available.

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9AD.3
Near-Source Deposition of Rare Earth Element-Bearing Fugitive Dust: Open-Source Dispersion Modeling with pyAERMOD. SHANNON CAPPS, *Drexel University*

Fugitive dust from open-pit mining operations is a significant source of coarse particulate matter, yet accessible tools for modeling size-resolved dispersion and dry deposition around mine sites remain limited. AERMOD, the U.S. EPA's preferred regulatory dispersion model, supports size-resolved particle dry deposition through a multi-bin resistance scheme accounting for gravitational settling, quasi-laminar sublayer resistance, and surface characteristics. However, its Fortran-based, file-driven interface creates significant barriers to ensemble modeling, parameter sensitivity analysis, and integration with broader scientific workflows.

We present pyAERMOD, a new open-source Python wrapper for AERMOD that programmatically generates input files, executes model runs, and parses outputs within a modern scientific Python environment. PyAERMOD includes functional preprocessors for AERMET (meteorological data processing) and AERMAP (terrain processing), along with a graphical user interface prototype, enabling end-to-end dispersion modeling workflows accessible to researchers without regulatory modeling backgrounds.

To demonstrate PyAERMOD's capabilities, we apply it to fugitive dust dispersion and size-resolved dry deposition from an open-pit rare earth element mine using AERMOD's OPENPIT source type and AP-42-derived emission factors. The coarse-dominated size distribution of mine fugitive dust is well-suited to AERMOD's Method 1 deposition algorithm, which computes gravitational settling and deposition flux independently for each particle size bin. PyAERMOD's scripting interface enables ensemble runs across particle size distributions, meteorological conditions, and source configurations — sensitivity analyses that would be impractical with AERMOD's native interface — providing insight into how deposition patterns around mine sites depend on aerosol size distribution assumptions.

PyAERMOD is designed to lower the barrier to regulatory-grade dispersion modeling for the aerosol research community and to serve as a platform for coupling physics-based dispersion with downstream aerosol processes. Source code and documentation shall be publicly available.

9AD.4
Boundary-Element Simulation of Broadband Extinction Properties of Engineered Magnesium Aggregates for Warming Mars. HAO ZHANG, Cyprien Jourdain, Edwin Kite, Adam Boies, *Stanford University*

Modern Martian atmosphere has a thin CO2 atmosphere (~6 mbar) and requires a temperature increase of ~30 K to initiate melting of shallow ground ice. Greenhouse warming provides only ~5 K mainly through a narrow 15 μm band and requires high species concentration. Engineered aerosols offer an alternative by reducing upwelling thermal-infrared losses while maintaining high transmission of incoming sunlight, while their performance depends sensitively on particle refractive index, morphology, and wavelength-dependent absorption and scattering cross sections across solar and planetary thermal radiation regimes. Previous work [1] has demonstrated the feasibility of warming Mars with conductive nanorod, but the limited atmospheric lifetime due to degradation and the difficulty of large-scale synthesis poses challenges for deployment.

In this work, we investigated the extinction properties of magnesium (Mg) aggregate nanoparticles with low fractal dimension. Broadband optical cross sections from visible light to long-wave infrared (>20μm) are simulated using boundary element method implemented in BEMpp [2]. This approach solves Maxwell’s equations on particle surfaces, enabling efficient computation of irregular, sintered metal aggregates. The effect of fractal dimension, primary-particle diameter, and the number of primary particles on spectral extinction are examined to explore optimal design parameters. The calculations show that long-wave extinction is governed by the aggregate’s longest electrically connected length scale, where the incident field drives an induced current and produces an antenna-like resonance when the effective wavelength approaches twice of the connected length scale. In parallel, laboratory synthesis is being pursued to generate comparable Mg aggregate morphologies and validate the numerical results. These results provide a framework for screening engineered aggregate designs that maximize infrared opacity while minimizing undesired visible extinction. The ultimate goal is to couple the extinction spectra with a Mars climate model to quantify their transport behavior and the resulting impacts on the Martian surface temperature and climate.

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9AD.5

Chemical Properties of Postfire Dust. VERA SAMBUROVA, Yasaman Raeofy, Ayalkibet Mekonnen Seka, Eden Furtak-Cole, Markus Berli, Hans Moosmüller, *Desert Research Institute*

Wildfires have intensified over the past few decades, resulting in significant health, ecological, and economic impacts worldwide, particularly in western North America. Despite the increasing frequency of wildfires, post-fire emissions, especially entrained dust, remain poorly characterized. Residual ash, dust, and soil from burned areas can result in enhanced dust entrainment. Once entrained, they can be transported downwind over hundreds of kilometers, posing risks to environmental and human health on timescales ranging from months to years. However, the roles that these resuspended particles, particularly ash, dust, and soil, play in air quality, toxicity, and broader environmental impacts remain insufficiently understood.

The goal of this work is to address these knowledge gaps by investigating the chemical composition and physical characteristics of post-fire particles, especially those with high entrainment potential. Specifically, we characterized dust (including ash and soil surface material) after test burns of sagebrush on representative northern Nevada soil. Sagebrush fires are known to be among the largest and most widespread in the western U.S., yet their effects on the generation of post-fire dust remain poorly characterized.

To perform the controlled combustion experiments, a barrel-based setup, instrumented with a set of thermocouples, was used. The barrel was filled with the selected soil and was loaded with sagebrush fuels on top. Five replicate burns were performed, and post-fire dust samples (ash and burned surface soils) were collected for further analyses. Their chemical functional groups were analyzed using Fourier transform infrared spectroscopy (FTIR) and proton nuclear magnetic resonance (^{1}H-NMR) techniques, while toxic organic compounds, such as polycyclic aromatic hydrocarbons (PAHs), were quantitatively analyzed using gas chromatography–mass spectrometry (GC–MS) to characterize the generated post-fire dust, with an emphasis on its potential toxicity.

9AD.6

Chemistry of Post-Fire Dust and Soil Water Repellency. YASAMAN RAEOFY, Vera Samburova, Markus Berli, Eden Furtak-Cole, Ayalkibet Mekonnen Seka, Hans Moosmüller, *Desert Research Institute*

Wildfires have recently increased in frequency and intensity in the western US. They can increase Soil Water Repellency (SWR), potentially triggering post-fire disasters including mudslides, soil erosion, and flooding and they can enhance Post-Fire Dust (PFD) entrainment.

Despite numerous studies, the chemical nature of PFD and SWR remains poorly understood at the molecular level. Our research focuses on chemical characterization of PFD and SWR through a series of laboratory-based experiments on organic compounds including abietic and fulvic acids, which serve as surrogates for plant wax components and soil organic matter. To study the impact of temperature and heating duration on the formation of SWR during fires, organic-free test sand was treated with the selected organic acids and heated to different temperatures and with different exposure durations. Results for these soil samples were compared with those for PFD and soil samples from a real fire (Beckwourth Complex Fire), Whittell Forest soils, and laboratory burn soil samples.

Water Drop Penetration Time (WDPT) and Apparent Contact Angle (ACA) techniques were used to quantify SWR. The organic compounds associated with SWR formation were characterized with Fourier Transform Infrared (FTIR) and Proton Nuclear Magnetic Resonance (1H-NMR) spectroscopy. Based on goniometry results, abietic acid showed stronger SWR (ACA: 89.9º–105.0º) than fulvic acid (ACA: 52.0º–90.0º) when heated from 22°C to 300°C for 40 minutes, and both organic acids maintained SWR up to ~300℃.

Laboratory-generated and real fire soil and dust samples also showed a significant increase in SWR (ACA) between burned and unburned samples (~22% – ~159% increase). Based on 1H-NMR and FTIR analyses of chemical functional groups, we conclude that the formation of aromatic structures and decarboxylation (-COOH) processes likely represent the chemical nature of organics in PFD and are key mechanisms for driving SWR development during fires.

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9AD.7

Great Salt Lake Dust and Urban Air Quality: A Two-Year Sensor Network Study. TRISTALEE MANGIN, Dillon Tang, Yiqing Meng, Nancy Daher, Kerry Kelly, *University of Utah*

Dust emissions from the drying Great Salt Lake (GSL) are an increasing air quality concern in Utah's Salt Lake Valley. In 2022, the GSL reached historically low levels, exposing approximately 1,945 km2 of lakebed and creating new sources of windblown dust. These dust sources are a particular health concern because they contain heavy metals, including Pb and As. In addition to GSL dust, this airshed is impacted by dust originating from the West Desert and industrial gravel and mining sources. However, understanding the spatial variability of dust (PM10) across the Salt Lake Valley is limited by sparse regulatory monitoring. To address this gap, we deployed a network of over 15 low-cost sensor nodes across the Salt Lake Valley. These nodes measured PM2.5 using Plantower PMS sensors and PM10 using Alphasense OPC-N3 sensors. We present an approximately two-year analysis of PM2.5 and PM10 concentrations (February 2024 to February 2026), focusing on spatial patterns and seasonal variability.

Preliminary results for summer 2024 show higher PM concentrations in the northwest quadrant of the valley, near the GSL and industrial sources, with hourly measurements reaching 348 µg/m3 PM2.5 and 2769 µg/m3 PM10, compared to 142 µg/m3 PM2.5 and 858 µg/m3 PM10 in the southeast quadrant. Additionally, we recorded measurements from a dust event originating from the West Desert on May 12, 2025, that lasted approximately 12 hours. Before the dust event, hourly PM10 concentrations were approximately 10-20 µg /m3 across the Salt Lake Valley. During the dust event, hourly PM10 concentrations reached approximately 800-1200 µg/m3. These findings demonstrate the value of dense sensor networks for resolving neighborhood-scale variability in particulate pollution and highlight the importance of improved coarse particle measurements for assessing dust-related exposures.

9AD.8

Elucidating the Impact of the Saharan Dust Layer on Chlorine Radical Formation Through Field Observations in the Atlantic Tropics. EMMA J. PELLERIN, Lauren A. Garofalo, Delphine K. Farmer, Katelyn Rediger, Tyson Berg, Adam De Groodt, Morgan Selby, Julia Marcontonio, Bighnaraj Sarangi, John Mak, *Colorado State University*

Oxidation of methane by chlorine radicals has been proposed to impact its lifetime in the marine tropical troposphere. In the Atlantic tropics, chemical reactions of chloride from sea-spray aerosols (SSAs) mixed with iron-rich Saharan dust layer (SDL) could create molecular chlorine (Cl_2) which can then be photolyzed to generate Cl radicals. The importance of this mechanism is not well constrained due, in part, to the lack of chemically comprehensive measurements during dust events in the marine boundary layer. To investigate Cl_2 and other oxidants during both dust-impacted and more clean conditions, we conducted a field study on the northeastern coast of Puerto Rico at the Reserva Natural Las Cabezas de San Juan Para la Naturaleza site. We leveraged a suite of aerosol and gas-phase instruments, including an iodide chemical ionization mass spectrometer (I-CIMS) and x-ray fluorescence of filter samples collected offline. A remote sensing measured dust mass concentration dataset over Puerto Rico was compared against dust mass concentrations calculated from optical particle counting data collected at the site to determine preliminary evidence of dust events occurring during sampling time. I-CIMS measured a Cl_2 maximum of 7.07 ± 0.93 ppt during March, when dust was occasionally present, and 6.30 ± 0.74 ppt during July, when dust was steadily measured over the site. The diel profile of Cl_2 reveals a consistent photochemical source that is strongest at 10 am and stabilizes shortly after due to Cl_2 photolysis until 2 pm. This behavior is consistent with photolabile iron chloride complexes that may be forming from the interaction of SSAs and the SDL – or other photochemical pathways. This work includes analyzing aerosol iron and heavy metal content to investigate the relationship between the SDL and Cl_2 production. These datasets will help us investigate the heterogeneous mechanisms contributing to chloride activation in the marine tropical troposphere.

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9AD.9

Experimental Optical Characterization of Mineral Dust Aerosols Using Wide-Angle Angular Light Scattering.

PUBUDUNI EKANAYAKA, Hans Moosmüller, Prakash Gautam, *Desert Research Institute*

We present laboratory measurements of angular light-scattering intensity for aerosolized, micron-sized, irregular mineral dust particles of diverse types, with varying particle size distributions and morphologies. Measurements were conducted over a near-full angular range from 0.32° to 178.6°, enabling characterization of scattering behavior across the forward-, side-, and large-angle scattering regimes. The measured scattering data are analyzed using complementary visualization approaches, including (a) logarithmic intensity versus linear scattering angle (θ-space) and (b) logarithmic intensity versus logarithmic scattering wave vector magnitude, q (Q-space analysis). Together, these approaches provide complementary views of the wide-angle scattering data, where θ-space better highlights behavior in the large-angle scattering regime, while Q-space enhances interpretation in the forward- and side-scattering regimes.

Results demonstrate that light-scattering-inferred particle diameters are in good agreement with intensity-weighted mean particle sizes obtained from aerodynamic particle sizing measurements, emphasizing the importance of intensity-weighted size distributions in interpreting optical observations. Comparisons with Mie theory calculations for volume-equivalent spherical particles show reasonable agreement in the small-angle scattering regime, but increasing deviations at larger scattering angles, reflecting the influence of irregular particle morphology and structural complexity not captured by spherical approximations.

9AD.10

Single-Particle Analysis of Wintertime Dust in Salt Lake City, Utah.

SHATABDI ROY, Emily Costa, Tiantian Zhu, Holly Lawson, Theo Severud, James Christie, Logan Forshee, Vanessa Selimovic, Maria Garcia, Anna Gannet Hallar, Cassandra Gaston, Kerri Pratt, *University of Michigan*

Dust is a major contributor to atmospheric particulate matter, particularly in urban environments. In the Salt Lake City (SLC), Utah urban basin, dust originates from multiple sources, including resuspended road dust, urban soils, vehicular emissions (e.g., brake wear), industrial activities, and the exposed playa of the Great Salt Lake. There is public concern about dust in this region that may contain trace levels of toxic metals that can enhance aerosol toxicity through the generation of reactive oxygen species, which can cause respiratory health issues. Secondary aerosol can also form on dust, especially for saline dust that participates in heterogeneous halogen and nitrogen chemistry. While prior work has characterized dust sources and composition in the region, these studies have largely relied on bulk analytical techniques. As a result, the contribution of different types of dust particles to aerosol composition, mixing state (distribution of chemical species in individual particles across a population), and chemical reactivity remains poorly resolved at the single-particle level. Size-resolved samples (0.18-3.2 µm aerodynamic diameter) were collected using a miniature micro-orifice uniform deposit impactor (mini-MOUDI) in SLC during Jan.-Feb. 2024. Single-particle analysis was conducted using computer-controlled scanning electron microscopy with energy dispersive X-ray spectroscopy (CCSEM-EDX) to characterize individual dust particles. This approach provides particle size, morphology, and elemental composition, allowing assessment of chemical heterogeneity in the dust particle population. This study aims to examine the composition of individual dust particles in SLC during wintertime pollution events. By resolving particle-level variability, this work seeks to identify dominant dust sources, evaluate their association with trace metals, and assess their potential roles in atmospheric chemistry and air quality. Improved understanding of dust composition and mixing state will provide critical insight into its contribution to urban pollution and potential health impacts in the SLC region.

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9AD.11

Thin Secondary Organic Aerosol Coatings Suppress Heterogeneous Ice Nucleation of K-feldspar Dust. YUZHI CHEN, Gourihar Kulkarni, Alla Zelenyuk, Nurun Nahar Lata, John Shilling, *Pacific Northwest National Laboratory*

Mineral dust is the most abundant aerosol component by mass and among the most efficient ice-nucleating particles (INPs) in the atmosphere. Previous research has shown that secondary organic aerosol (SOA) coatings can suppress the deposition freezing efficiency of Arizona Test Dust and illite particles. The suppression appears to be dependent on coating thickness or surface coverage as well as dust type, as mineral structure sets the baseline upon which coatings exert their influence. In this study, we investigated the heterogeneous ice nucleation ability of K-feldspar dust particles with thin α-pinene SOA coatings in deposition freezing mode (-40 to -42 °C). Polydisperse K-feldspar dust particles were first injected into a ~1 m^3 custom-built FEP chamber, followed by injection of α-pinene and H2O2. UVA blacklights initiated the OH-driven oxidation of α-pinene, producing SOA that coated the dust particles. Dust particles with an aerodynamic diameter (da) of 835 nm were selected by an Aerodynamic Aerosol Classifier (AAC) and were continuously sampled using a single particle mass spectrometer (miniSPLAT) and an ice nucleation chamber (INC). miniSPLAT unambiguously showed a concurrent increase of vacuum aerodynamic diameter (dva) and α-pinene SOA mass spectral peaks, indicating SOA is smoothing the surfaces or/and filling voids of the initially non-spherical dust particles (i.e., thin SOA coating). Even with these thin SOA coatings, INC results showed a significant suppression of deposition freezing efficiency with up to a 2-order-of-magnitude reduction in active site density. Dust can acquire SOA coatings during its atmospheric transport and aging. Our results show that dust's ice-forming capacity may be significantly reduced, even after a minimal SOA formation under cirrus conditions.

9AD.12

Characterizing Mineral Dust Physical Properties and Vertical Profiles in Oklahoma, U.S. HAYDEN WEBB, Sandra Marcela Loria Salazar, Connor Flynn, Hans Moosmüller, *University of Oklahoma, School of Meteorology*

The Southern Great Plains region, particularly Oklahoma, experiences a wide range of aerosol activity influenced by both local emissions and long-range transport. Although previous studies in this region have focused on wildfire-emitted black carbon, mineral dust has received comparatively less attention. Oklahoma is affected by elevated dust levels from local agricultural activities and transported dust from regions such as Texas and New Mexico. To better understand dust's impact on climate and public health in this region, this work investigates aerosol physical properties and their vertical distribution using a variety of datasets. Specifically, aerosol optical depth (AOD), single scattering albedo (SSA), and extinction Ångström exponent (EAE) are characterized through in situ measurements from NASA's AEROENT network and satellite retrievals from DSCOVR EPIC MAIAC, and these results are compared with vertical profiles derived from lidar polarimeter observations. This study aims to reduce uncertainties in the direct radiative effect of mineral dust, which is largely attributed to variations in its composition and evolution during transport (Shao et al. 2011; Baker and Croot 2010).

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9AD.13

Detecting Dust Particles During Dust Events Using Low-Cost Sensors. KARIN ARDON-DRYER, John Garber, Melodie Martinez-Manahan, *Texas Tech University*

Dust events are one of the main natural contributors to atmospheric aerosols, and a major concern for health, transportation, and air quality. Dust events contain high Particulate Matter (PM) concentrations, even high concentrations of small particles (<0.5 μm). But dust events are not often prioritized in air quality mitigation strategies. One of the reasons is insufficient measurement and instrument networks that track and examine dust events and their impact on air quality, coupled with the inability of low-cost sensors to detect dust particles.

As part of this project, we performed calibration corrections in a semi-arid environment of West Texas that experiences many dust events using two commonly used low-cost sensors, the Clarity Node-S and PurpleAir PA-II. The units were placed in the AErosol Research Observation Station (AEROS), which hosts the reference monitor GRIMM EDM-180. Different corrections were developed for each unit for PM2.5 using a variety of different variables. The presentation will highlight the different corrections developed, their advantages and disadvantages, and whether the Clarity Node-S and PurpleAir PA-II can detect dust particles during dust events.

9AD.14

Persistent Monsoon Aerosol Loading over the Western Himalaya from Multi-Dataset Observations and Transport Analysis. ABIDINA BELLO, Anshuman Bhardwaj, Lydia Sam, *University of Aberdeen, UK*

Aerosol loading over the Himalaya is generally expected to decrease during the monsoon because of enhanced wet scavenging. However, satellite observations over the Western Himalaya (WH) indicate sustained high aerosol optical depth (AOD) during this period. This study examines seasonal aerosol variability over the WH using MOD08_M3 AOD observations from 2000–2023, together with SeaWiFS aerosol products, MERRA-2 dust optical depth (DOD), and HYSPLIT backward trajectory analysis. Aerosol variability was analysed within four elevation bands (0.2–2 km, 2–4 km, 4–6 km, and >6 km). The WH shows a monsoon AOD maximum across all elevation bands. At lower elevations (0.2–2 km), mean AOD increases from 0.46 ± 0.11 during the pre-monsoon season to 0.89 ± 0.20 during the monsoon, corresponding to an increase of approximately 94%. Elevated monsoon AOD is also observed at higher elevations, although with lower magnitude. Comparison with independently processed Giovanni MODIS AOD shows strong agreement ($R^2 = 0.78$), while SeaWiFS observations reproduce a similar seasonal pattern, suggesting that the observed monsoon enhancement is consistent across datasets. MERRA-2 DOD indicates sustained dust loading over the WH during both pre-monsoon and monsoon seasons, with DOD remaining relatively high (~0.10–0.11) during the monsoon period. HYSPLIT trajectories show persistent westerly and south-westerly transport pathways into the region during the monsoon season, consistent with continued aerosol transport. The results suggest that wet scavenging alone may not fully explain monsoon aerosol behaviour over the Western Himalaya. Continued regional and long-range transport, including dust transport, likely contributes to maintaining elevated monsoon aerosol loading over the region.

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9AD.15

Direct-on-Filter Raman Spectroscopy for Quantifying Respirable Crystalline Silica: Challenges and Considerations.

XIAOLIANG WANG, Bankole Osho, Lily Raymond, Mohammadreza Elahifard, Yifei Jin, Behrooz Abbasi, Judith Chow, John Watson, *Desert Research Institute*

Inhalation of respirable crystalline silica (RCS) is a significant occupational health risk, particularly in mining and construction industries. This study evaluates the feasibility of Raman spectroscopy for the quantitative analysis of RCS using a direct-on-filter (DoF) approach. Key challenges include analysis sensitivity, spatial and chemical nonuniformity, fluorescence interference, and laser-induced heating effects. Results show that quantifying RCS on conventional 37 mm diameter filters is uncertain due to insufficient areal loading, while concentrating samples onto a 9 mm diameter deposit area using a filter holder adaptor significantly enhances sensitivity. Raman microscopes, which have small integration areas, are susceptible to deposit nonuniformity, whereas portable Raman spectrometers with larger laser beam diameters reduce this effect but remain sensitive to chemical heterogeneity. Laser-induced heating and photodegradation can remove organic compounds directly on the filter, thereby reducing both background signal and fluorescence and improving RCS measurement. These findings provide insights into the feasibility of Raman spectroscopy for RCS quantification, particularly in complex sample matrices such as coal dust.

9AD.16

Integrated Impacts of Smog Pollution and Ecosystem Degradation on Urban Livability and Economic Sustainability in Pakistan.

NABEELA FARAH, *Independent Researcher*

Pakistan boasts a diverse ecosystem ranging from northern alpine glaciers (K2) and coniferous forests to southern mangroves and deserts. The country is currently facing one of the world's most severe air pollution crises, with persistent smog events and hazardous concentrations of particulate matter (PM2.5) significantly affecting environmental sustainability, public health, and economic stability. This study investigates the integrated impacts of atmospheric aerosol pollution and ecosystem degradation on urban livability and economic sustainability across major Pakistani cities and ecological regions. The research examines how industrial emissions, vehicular exhaust, biomass burning, and transboundary pollution contribute to prolonged smog episodes that adversely affect forests, agricultural productivity, glacier systems, river ecosystems, and biodiversity.

Special attention is given to the interconnected relationship between aerosol deposition and ecological stress, including reduced crop yields, forest decline, accelerated glacier melting in the Himalayan–Karakoram region due to black carbon accumulation, deterioration of freshwater quality, and habitat disruption in sensitive ecosystems. The study further evaluates how these environmental changes intensify urban challenges such as respiratory and cardiovascular diseases, heat stress, reduced workforce productivity, increased healthcare expenditures, educational disruptions, and declining quality of life in densely populated cities including Lahore, Karachi, and Faisalabad.

Using an interdisciplinary framework combining air quality data, environmental indicators, public health statistics, and socioeconomic assessments, the research highlights the growing threat of environmental un-livability and economic disruption associated with persistent smog conditions. The study also explores sustainable mitigation and adaptation strategies, including green urban infrastructure, clean transportation systems, industrial emission controls, renewable energy transition, urban forestry, and regional environmental cooperation.

The findings aim to support evidence-based policymaking and promote integrated environmental management approaches to improve urban resilience, ecological sustainability, and public well-being in Pakistan under worsening climate and pollution conditions.

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9AD.18

Laboratory Investigation of Mineral Dust Charging for Improved Understanding of Coarse Mode Mineral Dust Transport. JUNE NORWOOD, Kyle Gorkowski, Claudio Mazzoleni, Hans Moosmüller, *Michigan Technological University*

Coarse-mode mineral dust travels farther and stays aloft longer than many atmospheric models predict. Neglecting bulk particle charging and the resulting plume- scale differential field formation is one possible proposed partial solution. We measure the individual particle charge distribution of Arizona Test Dust in a grounded chamber that reproduces the parts of a steady plume needed for this question: sustained dust flow, measured ion background, size sorting, and separated sampling heights. The test cases used fine dust, coarse dust, and a mixed fine–coarse dust case in dry air, plus one humid mixed-dust case. Two vertically separated through-type Faraday cups (FC1 and FC2) measured electric charge at different heights in the plume. An aerodynamic particle sizer measured particle size, and ion and environmental sensors measured the chamber conditions. Our measurements showed significant field growth in the dry plume cases: the measured charge distributions retain a net signed offset after size correction and produce non zero field estimates. In the dry cases, the FC2-based field is larger than the FC1-based field, with estimated magnitudes of about 0.1 - 1 V/m. We approached estimating the settling response using various different modeling assumptions. Using a poisson electric field model within the chamber, as well as conservative estimations for fields observed within dust generating plume conditions, we find the modeled net vertical field change is largest for the smallest measured particles and drops quickly after a coarse diameter of roughly 3 microns. Tests varying plume dust grade and RH, coupled with different assumptions for the halflife of charge decay--once the individual particles leave the plume and enter the Saharan Air Layer for example--yielded predictions of a difference in settling time due to coulomb forces from 5-10% for certain size ranges of particles within certain case sieve size distributions. The steady state charge loss model, chamber transmission, ballistic clumping assumptions, and humid-case treatments are varied to perform different sensitivity analysis.

9AE.1

Variability in Lung-Deposited Surface Area Within Particulate Matter ≤2.5 µm. KIAN HUANG LEE, Agisilaos Kourmatzis, Troy J. Cross, *The University of Sydney*

Particle size governs aerosol deposition mechanisms and regional dose within the respiratory tract. Within particulate matter with aerodynamic diameter ≤2.5 µm (PM2.5), variability in particle size distributions can lead to differences in inhaled dose that are not reflected by bulk mass concentration. This study quantifies how size-resolved aerosol distributions influence lung-deposited surface area (LDSA) within PM2.5. Aerosol size distributions (0.01–2.5 µm) from the Atmospheric Radiation Measurement (ARM) network, (n = 92,091 hours; 6 sites) were coupled with deposition fractions from the Multiple-Path Particle Dosimetry (MPPD) model to estimate regional deposition and LDSA. The size spectrum was split into nanoparticles (<0.1 µm), submicron particles (0.1–1 µm), and fine particles (1–2.5 µm). Mass within PM2.5 was dominated by submicron (62.2±20.8%) and fine particles (32.8±21.7%), while nanoparticles contributed a small fraction (5.0±4.4%). In contrast, total LDSA was primarily associated with the submicron fraction (59.1%±17.3%), with nanoparticles contributing disproportionately (29.6%±16.5%). A similar pattern was observed in the alveolar region, where nanoparticles contributed 31.7±17.0% of LDSA despite their low mass fraction. Submicron particles most frequently dominated total LDSA (77.1%), whereas fine particles most frequently dominated PM2.5 mass (74.7%). At comparable mass concentrations, LDSA varied by 3–5-fold between the 10th and 90th percentiles across most PM2.5 ranges, increasing to 8.02-fold at concentrations >100 µg/m³ (n = 520). Submicron mass scaled strongly with PM2.5 (R^2 = 0.74), whereas LDSA showed weaker relationships ($R^2 \leq 0.49$). These results show that variability in particle size distributions within PM2.5 leads to substantial differences in LDSA. Consideration of size-resolved structure and particle surface area is therefore important for accurately characterising inhalation exposure and associated health risks.

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9AE.2

Experimental Deposition of Nicotine-Containing Aerosol in an Airway Cast Model. CHIH-HSIANG CHIEN, Shipeng Kang, Matt Melvin, Weiling Li, Da-Ren Chen, *Altria Client Services LLC*

In this study, we established an experimental platform using a 3D-printed cast airway model based on Computed Tomography scan data to quantify the regional deposition of nicotine-containing aerosols. The above model includes the mouth-throat and trachea regions, and airways to the 9th generation (with 72 bronchi categorized into five lobar subtrees). Test aerosol particles were generated by three different aerosol generators: a flow-focusing monodisperse aerosol generator, a thermal e-cigarette device, and a non-thermal vibrating mesh nebulizer (VMN) for water-based aerosols. Nicotine deposited on the inner surfaces of the cast model and onto filters was extracted with methanol and quantified by LC-MS.

The model validation was first performed by comparing the measured deposition in different regions of a lung with those reported in the literature (as a function of particle size and inhalation flow rate). The consistent results between measured and published data demonstrates validation of the model platform. Using the validated platform, we investigated the effects of solution formulation and aerosol formation mechanisms on the lung deposition of nicotine-containing particles. Preliminary experimental results indicated that aqueous nicotine-salt droplets reduced the nicotine deposition in the mouth-throat region compared to results from unprotonated nicotine droplets. The comparison of deposition data for droplets generated thermally and non-thermally showed that the mouth–throat deposition was increased for VMN-generated droplets (approximately 4-5 μm) when compared with that for thermal-generated aerosol, while the overall mouth-throat droplet deposition remained below 5% for scenarios evaluated in the current dataset. The inertia-driven droplet deposition by using VMN motivated the investigation of the impact of the delivery angle on the deposition of droplets in the mouth-throat region. The results showed that the change of injection angle from 0° to 45° altered the regional deposition patterns and increased the mouth-throat deposition of droplets.

9AE.3

Evaluation of the MiniWRAS Portable Wide-Range Aerosol Spectrometer. Jonathan Berkuta, Stephanie Richards, Qiang Wu, Mackenzie Werderman, SINAN SOUSAN, *East Carolina University*

Real-time aerosol characterization across ultrafine, fine, and coarse particle fractions remains technically challenging, particularly in portable platforms intended for field deployment. The MiniWRAS portable wide-range aerosol spectrometer combines an electrometer-based NanoSizer with an optical particle counter to provide continuous size-resolved aerosol measurements in a compact platform. Although MiniWRAS is increasingly used as a laboratory reference instrument, direct evaluation against established SMPS + APS reference measurements remains limited. This study evaluated the MiniWRAS against a combined SMPS + APS system using polydisperse sodium chloride, Arizona road dust, and kerosene oil aerosols at environmental and occupational concentrations, along with monodisperse DEHS particles from 0.1 to 5.0 μm. For monodisperse aerosols, MiniWRAS detection efficiency was near 100% at 1.0 μm and 2.0 μm, measuring 95.2% and 97.1%, respectively, but deviated substantially at the size extremes, reaching 616.7% at 0.1 μm and 265.5% at 5.0 μm. The MiniWRAS systematically underestimated mass median diameter for monodisperse particles at and above 1.0 μm, recording 0.595 μm and 4.234 μm at the 1.0 μm and 5.0 μm targets, respectively, compared with 0.929 μm and 4.915 μm for the SMPS + APS. For particles 0.2 μm and larger, MiniWRAS geometric standard deviation values were broader than those from the SMPS + APS, indicating lower size-classification precision. For polydisperse aerosols, agreement varied by aerosol type and concentration range. Salt showed the closest MMD agreement at environmental concentrations, Arizona road dust showed the largest MMD overestimation, and kerosene oil showed the closest number concentration distribution agreement, particularly at occupational concentrations. Overall, the MiniWRAS performed most reliably in the 1.0 to 2.5 μm range, but overcounted ultrafine particles, underestimated MMD for larger monodisperse particles, and produced broader or artifact-prone mass distributions for some polydisperse aerosols.

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9AE.4

Inter-Instrument Comparison of the DC-IV, APS, and MiniWRAS for Droplet and Aerosol Characterization of Ultra-Low-Volume Mosquito Control Sprays. SINAN SOUSAN, Stephanie Richards, Qiang Wu, Krista Bryant, Abdulahi Opejin, Jonathan Berkuta, *East Carolina University*

Vector-borne diseases remain a major public health concern, and ultra-low-volume (ULV) systems are widely used to generate small droplets (generally <30 µm) of adulticides that contact flying mosquitoes. Accurate droplet size characterization is essential for equipment calibration and interpretation of insecticide efficacy studies, yet available instruments rely on different measurement principles and report different equivalent diameter types. This study compared a nozzle-level droplet counter (DC-IV) with two downstream aerosol instruments (TSI APS 3321 and GRIMM MiniWRAS 1.371) for characterizing ULV sprays under controlled chamber conditions. Mineral oil and kerosene were atomized at pressures of 1.0 to 10.5 bar and flow rates of 0.20 to 1.00 mL/min. Inter-instrument comparisons of mass median diameter (MMD) and count median diameter (CMD) were performed alongside regression and size distribution analyses. Four MMD calculation methods were evaluated, including the Hatch-Choate conversion and a Volume-Based method. For mineral oil, the DC-IV reported a mean MMD of 30.78 µm compared to 4.88 µm for the APS and 3.15 µm for the MiniWRAS (all pairwise $p < 0.001$); for kerosene, these differences narrowed to 6.21, 6.45, and 4.09 µm, respectively, with the DC-IV not significantly different from either aerosol instrument ($p = 0.497$ and $p = 0.455$). Regression models explained 61.0% and 81.5% of MMD variance for DC-IV and MiniWRAS with mineral oil. The APS-to-MiniWRAS MMD ratio was stable for kerosene (mean 1.57, SD = 0.05) but more variable for mineral oil under high-disagreement conditions. The Hatch-Choate conversion produced unstable estimates when the lognormal assumption was violated. The Volume-Based method reproduced the reported MMDs for the APS and MiniWRAS within ±1%, but not for the DC-IV. These results support continued DC-IV use for nozzle calibration while indicating that the APS and MiniWRAS could provide real-time characterization of the downstream airborne aerosol fraction, pending field validation against bioassay outcomes.

9AE.5

Laboratory Evaluation of the Sensirion SEN66, Piera IPS-7100, PurpleAir PIXEL and OPC-N3 Low-Cost Aerosol Sensors for Environmental and Occupational Exposure Monitoring. MACKENZIE WERDERMAN, Stephanie Richards, Jonathan Berkuta, Sinan Sousan, *East Carolina University*

Low-cost particulate matter (PM) sensors offer an affordable approach for monitoring air quality in both environmental and occupational settings, although their performance across different aerosol types and concentration ranges has not been demonstrated for newer sensor models. We measured the concentrations of three aerosols (salt, Arizona road dust, and kerosene) with four low-cost sensors (OPC-N3, IPS-7100, SEN66, and PurpleAir PIXEL), a photometer (pDR-1500), and reference instruments (SMPS and APS) at environmental (0–40 µg/m³) and occupational (50–2,500 µg/m³) concentrations. Monodisperse DEHS particles (0.1–5.0 µm) were used to assess detection efficiency and particle sizing accuracy. At environmental concentrations, all sensors were highly linear with the reference ($R^2 > 0.93$) across aerosol types, with the SEN66 exhibiting the highest inter-sensor precision (CV < 10%). The IPS-7100 showed strong agreement with the reference for PM1 salt at occupational concentrations (slope = 1.26, R^2 = 0.99, bias = −20.6%), while the OPC-N3 achieved near-unity performance for kerosene PM10 (slope = 1.20, R^2 = 1.00, bias = −0.6%) and kerosene PM4 (slope = 1.39, R^2 = 1.00, bias = 1.8%) at occupational concentrations. The detection efficiency of the OPC-N3 was near 100% at 2.5 µm, although overcounting was observed at other sizes. Aerosol type strongly influenced sensor response, underscoring the need for aerosol-specific calibration to assess device suitability for different aerosol applications before field deployment. Once calibrated, the high linearity observed across sensors and aerosol types suggests that these low-cost sensors can provide reliable estimates of PM mass concentrations at levels relevant to both ambient air quality monitoring and occupational exposure assessment.

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9AE.6

Spatiotemporal Gap-Filling of NASA Deep Blue Satellite Aerosol Optical Depth over the Contiguous United States (CONUS) Using the UNet 3+ Architecture. JEFFREY LEE, Sandra Marcela Loria Salazar, Heather Holmes, Andrew Sayer, *University of Oklahoma, School of Meteorology*

Due to sensor and algorithmic constraints, satellite aerosol optical depth (AOD) retrievals are spatially incomplete and have gaps caused by clouds and bright surfaces. These gaps represent a barrier in characterizing daily aerosol loadings, which is important for air quality applications. In particular, recent studies in aerosol studies have shown satellite AOD to be a useful predictor of particulate matter, but are often limited to monthly or longer temporal resolution because of missing AOD retrievals. In this study, we propose using a UNet 3+ to fill gaps in satellite AOD retrievals. We tested the hypothesis that UNet 3+ trained on deep blue (DB) AOD and supplemental data sets (e.g., Modern-Era Retrospective analysis for Research and Applications, Version 2 reanalysis AOD, meteorological and land-use variables from North American Mesoscale Forecast System, and Hazard Mapping System smoke polygons) will improve the availability of AOD data accurately. We created spatiotemporal data sets of daily, gap-filled DB AOD from 2012 to 2023 over the CONtinental United States (CONUS) at a 12 × 12 km2 resolution. We were able to train the model and perform the gap-filling in ∼10 hr, resulting in an increase of AOD data availability by 281%. We demonstrated that our approach is feasible over CONUS through quantitative and qualitative evaluations against AERONET and DB AOD. In statistical evaluations, our gap-filled AOD data set attained an RMSE ∼ 0.09 and a r ∼ 0.87 against collocated AERONET retrievals, compared to an RMSE ∼ 0.11 and a r ∼ 0.86 that the original DB AOD retrievals scored against AERONET. We plan to use this data set for future air quality and health investigations.

9AE.7

Applications of Novel Gap-Filled Aerosol Optical Depth and Data Fusion Techniques for Enhanced Surface PM2.5 Estimates. JEFFREY LEE, Sandra Marcela Loria Salazar, Heather Holmes, *University of Oklahoma, School of Meteorology*

The increasing contribution of natural aerosol emissions, coupled with variability in anthropogenic sources, has intensified the need for robust methods to model the spatiotemporal distribution of atmospheric particulate matter. Chemical transport models (CTMs), such as CMAQ, remain the primary tool for this task but exhibit persistent biases in reproducing surface-level PM2.5 concentrations. In this study, we present a data-driven framework for estimating historical PM2.5 distributions that integrates satellite retrievals with statistical modeling. The approach first applies a deep learning-based gap-filling method to satellite-derived aerosol optical depth (AOD) (Lee et al., 2025) to address missingness and improve spatial continuity. The reconstructed AOD fields are then combined with meteorological and land-use predictors within a statistical data-fusion model to infer surface-level PM2.5 concentrations. Preliminary results indicate that this workflow produces spatially coherent and physically plausible PM2.5 fields, capturing fine-scale structure that is often underrepresented in traditional CTM outputs. These findings suggest that hybrid, data-driven approaches offer a viable complement to process-based models for retrospective air quality estimation.

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9AE.8

Observation-Constrained Modeling of Airborne Toxic Metals: Identifying Toxicity-Driven Hotspots in California. JIE ZHANG, Ling Jin, Jia Xing, Bin Wang, *Lawrence Berkeley National Laboratory*

Trace metals in $PM_{2.5}$ pose substantial health risks, yet their spatial distributions and source-specific toxicity burdens remain poorly characterized in California. We develop an observation-constrained modeling framework to resolve the concentrations and source contributions of 23 trace metals across California. The framework assimilates metal observations with concentrations simulated by a high-resolution (4-km) source-tracked chemical transport model using a log-space Bayesian inversion. This approach provides spatially complete, observationally constrained concentration fields with explicit attribution to individual source sectors. Source-resolved concentrations are converted to element-specific Hazard Quotients (HQ) for non-carcinogenic endpoints and cumulative Cancer Risk (CR). The inversion markedly improves the representation of modeled spatial variability in individual metals. While the statewide population-weighted HQ is 0.22, localized toxicity exceedances (HQ > 1) persist in densely populated regions of Los Angeles. Risks are distributed unevenly across species: cadmium constitutes 12% of the combined mass of 11 toxic metals yet drives 74% of the total HQ. The statewide cumulative CR is 9.21×10^{-6}, corresponding to ~400 excess cancer cases, with cadmium, chromium (VI), and nickel accounting for 85% of total risk. The power & industrial sector emerged as the leading contributor to both non-carcinogenic risk (47%) and carcinogenic (44%) risks. By integrating high-resolution source-tracked modeling with Bayesian inversion, this framework supports toxicity-informed, source-specific air toxics mitigation strategies in California.

9AE.9

Investigating Air Quality Impacts of Rocket Emissions at Cape Canaveral Using Low-Cost Sensors. SPARTACUS STEPHENS, Marwa El-Sayed, Bethany Bothoff, Dori Stein, Sophia Beckwith, *Embry-Riddle Aeronautical University*

Over the past five years, commercial spaceflight activity at Kennedy Space Center in Florida has surged by more than 310%, prompting increased concern over the environmental and public health implications of rocket emissions. Rocket launches emit various air pollutants, notably particulate matter (PM), including black carbon (BC)and nitrogen dioxide (NO_2), both of which are regulated under the U.S. Clean Air Act due to their association with adverse health outcomes. However, existing U.S. Environmental Protection Agency (EPA) monitoring stations are located 20 to 40 miles away from launch pads, making them inadequate for capturing localized, near-field air quality impacts. To bridge this data gap, we deployed low-cost TELLUS AirU Pro sensors, calibrated against reference-grade monitors, at two locations within 20 miles of Launch Pad 39A, including Cape Canaveral City Hall and the Cape Canaveral Community Center. These sensors measured concentrations of $PM_{2.5}$, PM_{10}, carbon monoxide (CO), ozone (O3), and nitrogen oxides (NO_x) before, during, and after launch events to analyze pollutant dispersion over time and space. This research provides some of the first ground-based, real-time observations of localized air quality changes associated with modern rocket activity. The results can be used to validate existing models of rocket emission impacts and offer actionable insights for enhancing environmental health and safety strategies. More broadly, the study contributes valuable empirical data to support improvements in atmospheric emissions modeling and promotes the adoption of more sustainable practices across the aerospace sector.

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9AE.10

Unpaved Road PM10 Concentrations and Vehicle-Induced Transient Plume Characteristics. PATRICK O'SHAUGHNESSY, Drew Latta, James Kacer, David Cwiertny, *The University of Iowa*

Unpaved roads are common sources of fugitive PM emissions constituting 32% of all road types in the United States along which are millions of households. A multi-method approach was taken to identify particulate matter (PM) concentrations emanating from gravel roads that involved stationary beta-attenuation monitors (BAMs), filter-based samplers, a continuous metals analyzer, a direct-reading aerosol photometer, and low-cost “Purple Air” monitors. Samples were collected over 23 days during summer months near rural roads in eastern Iowa that were covered with limestone gravel or a mix of limestone and crushed steel slag. BAM results indicated a geometric mean of 50 μg m^{-3} but 18% of all 24-hr measurements exceeded the PM10 NAAQS limit of 150 μg m^{-3}. The addition of steel slag to the gravel roads elevated manganese levels by a factor of 1.3, however metal concentrations produced by both road surface types were otherwise similar. Instantaneous aerosol photometer responses to the plumes created by passing vehicles created exceedingly high, but short-lived PM concentrations. The average concentration was 4300 μg m^{-3} over a typical residence time of 7.4 s. Ongoing research involving the use of Purple Air monitors is providing results like that of the aerosol photometer by showing very high spikes in concentration above background due to passing vehicles. Interestingly, a dual correction factor is needed to correct the typical non-vehicle influenced concentrations with high numbers of small particles downward, and another to correct the road dust plume PM having high numbers of large particles upward. These results indicate that rural residents living near unpaved roads are at risk of adverse health effects due to inhalation of roadside PM10 from both 24-hr concentrations that can exceed the federal limit and inhaling exceedingly high short-term concentrations that can aggravate existing pulmonary conditions such as asthma.

9AE.11

Evaluation of PM2.5 and PM10 Exposure at School Athletic Fields and Childcare Centers in Utah. TRISTALEE MANGIN, Aaron Hanson, Alex Mass, Nancy Daher, Kerry Kelly, *University of Utah*

Poor air quality poses risks to children and young adults, with student athletes being particularly vulnerable due to elevated breathing rates during physical activity. To better characterize exposures in school environments, a network of low-cost sensors was deployed across Utah, including outdoor PM2.5 (Plantower PMS5003) and PM10 (Alphasense OPC-N3) measurements at 35 high school athletic fields, and indoor PM2.5 and CO2 (Senseair Sunrise HVAC) measurements at 15 early childhood education centers. Notably, nine schools were located in seven counties without existing state monitors. Our team also developed a public-facing website to provide real-time measurements and 3-day forecasts, searchable by school district, to support decision-making by educators, coaches, athletic trainers, school nurses, and administrators.

This presentation summarizes approximately one year of measurements (April 2024–May 2025), including the development of PM correction models (regression for PM2.5 and k-Kohler for PM10) based on sensor colocation with state reference monitors. Fifteen high schools recorded a total of 28 days exceeding the PM2.5 24-hour AQI threshold for Unhealthy for Sensitive Groups (35.5 μg/m^3) and 2 days exceeding the Unhealthy threshold (55.5 μg/m^3). Meanwhile, 21 schools recorded 46, 11, 4, and 6 exceedance days for PM10 at the Unhealthy for Sensitive Groups (155 μg/m^3), Unhealthy (255 μg/m^3), Very Unhealthy (355 μg/m^3), and Hazardous (425 μg/m^3) thresholds, respectively. Indoors, mean PM2.5 concentrations were low across facilities (1.32±1.18 μg/m3), yet eight childcare centers experienced a total of 50 days exceeding the WHO 24-hour PM2.5 concentration guideline (15 μg/m3). Since May 2025, our team has deployed an additional 26 indoor and 13 outdoor devices in 13 more schools. These results support the need for localized, actionable air quality information in school environments.

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9AE.12

The Impact of Seasonality on Cyanobacteria Harmful Algal Blooms on Lake Spray Aerosols. GRACE A. YOUNG, Carlie Poworoznek, Andrew P. Ault, *University of Michigan*

For the Great Lakes and freshwater lakes across the Midwest, cyanobacterial harmful algal blooms (cHABs) are a growing concern for human health. cHABs are an excessive biomass growth of cyanobacteria with highly variable timescales as the blooms are dynamic and continuously evolving systems. The health impacts of cHABs have historically focused on ingestion or dermal exposure, but in recent years toxins and metabolites formed by cHABs have been detected in aerosols. Inhaled cHABs pose a greater risk to health than ingestion or dermal contact, as inhaled toxins are far more potent due to sensitivity of the respiratory system. The extent to which aerosolized toxins impact the health of communities and regional meteorology near bodies of freshwater remains unclear. Each bloom differs in severity of dissolved toxins, physical properties, and chemical properties, the resulting number, size, and properties of aerosol produced vary widely. Additionally, factors driving bloom growth and properties are nutrient runoff (typically phosphorus and nitrogen), light availability, and temperature. However, to date aerosol production has not been connected with cHAB bloom seasonality. The frequency and intensity of cHABs are increasing as these anthropogenic nutrient loadings increase, and with a global increase in temperature, but there is substantial year-to-year and even month-to-month variation. Despite the potential risk to the health of populations living near the Great Lakes and lakes worldwide, a large knowledge gap remains in our understanding of the extent to which toxins and other cHABs produced organic species are aerosolized regionally. We aim to better understand how seasonality of cHABs effects the lake spray aerosols produced. We plan to do this through field collection of ambient aerosols and water collection throughout the bloom season. We will then look at the changing chemical composition via signal particle analysis, changes in the aerosol size distribution modes, and chemical analysis.

9AE.13

Indoor Versus Outdoor Aerosol Measurements in New Delhi and San Francisco. DEVABHAKTUNI SRIKRISHNA, Sonam Devabhaktuni, Sathyaraj Devabhaktuni, *PatientKnowhow.com*

It is a common public health advisory to stay indoors to escape outdoor pollution, assuming the indoor particulate exposure will be lower than outdoors. In this study we measured indoor versus outdoor particle concentrations during February 2026 in New Delhi, and we plan to include measurements of indoor versus outdoor concentrations in San Francisco during summer of 2026. Measurements were conducted using a 7-channel optical particle counter calibrated by the manufacturer. In New Delhi hotels and cafes, indoor measurements were often similar and in some cases much higher than outdoors (almost 4x higher in one case). One New Delhi hotel had a screen in its lobby displaying much lower indoor versus outdoor particles, but measurements with particle counter displayed nearly similar particle concentrations indoors versus outdoors. In conclusion, based on this data the public health preference for indoors to escape outdoor pollution may need to be qualified by the presence whether effective indoor air cleaning measures are in place or not.

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9AE.14

A Sooty Environment: Quantifying Exposure to Black Carbon in Bogotá, Colombia. RICARDO MORALES BETANCOURT, Karen Pinzón, Silvana Oliva Rodriguez, *Universidad de los Andes*

Exposure to particulate matter is a leading environmental issue due to its proven association with negative health outcomes. Quantifying exposure to air pollutants is typically carried out through fixed-site monitoring networks, designed to continuously monitor aerosol mass concentration to characterize the air pollution field in the vicinity of a given site. However, actual aerosol fields in urban environments often show strong spatial gradients due to proximity to sources and other characteristics of the surrounding built environment. Therefore, activity patterns, proximity to main roads, built-environment characteristics and exchange rates in indoor environments can severely influence overall exposure to air pollution. In this work we carry out a first attempt to quantify personal exposure to Black Carbon (BC), fine particulate matter ($PM_{2.5}$), and ultrafine particles (UFPs) for a variety of socio-demographic profiles in the city of Bogotá, in Colombia. Previous studies have already demonstrated large exposures in commuting microenvironments in the city, especially within the public transport system. However, no previous studies have aimed at quantifying all-day exposure for a wide range of profiles. In our study, we carried out personal exposure measurements of BC using portable aethalometers, $PM_{2.5}$ with laser photometers and gravimetric methods, and UFP measurements with portable condensation particle counters (CPCs). Individual measurements lasted at between 6 to 12 hours and were carried out for over 50 different individuals spanning diverse socio-economic backgrounds, occupations, mobility patterns, and geographic location within the city limits. Replicates for a given individual were also completed, totalling more than 80 sampling days. The data collection campaign lasted 10 months, from August 2025 to May 2026. Measurements included indoor measurements at the place of residence, place of work or place of study of the participants, as well as measurements during commuting and other daily activities. Furthermore, we expanded our measurements with available fixed-monitoring BC data as well as with data collected in the city in previously unpublished studies. The fixed monitoring-site annual BC concentration in the city ranges between 3.4 and 4.5 $\mu g\ m^{-3}$, which is 15 to 18% of the $PM_{2.5}$ measured at the same locations. These observations suggest a highly soot-impacted urban environment. From the personal exposure measurements, the mean BC concentration throughout the 10 months campaign was 5.5 $\mu g\ m^{-3}$, with a significant difference observed between outdoor (9.6 $\mu g\ m^{-3}$) and indoor (3.4 $\mu g\ m^{-3}$) BC concentrations. These results, although preliminary, suggest an urgent need to reduce soot emissions within the city, which are likely linked to mobile source emissions.

9AE.15

Health Risk Assessment of Airborne Formaldehyde Exposure at Different Occupational Zones. RUBAB REHMAN, Saiyada Shadiah Masood, Haider Khwaja, Aisha Sana, *Department of Chemistry, Jinnah University for Women*

Air pollution is the most alarming environmental issue in the south Asian region particularly in Pakistan that has delineated the quality of life at its worst level. Formaldehyde has been classified by the IARC as carcinogenic and mutagenic in nature, it is detrimental to air quality and human health. Its lifetime in the planetary boundary layer is a few hours, which exhibits its significant role in tropospheric photochemistry by acting as a precursor to free radicals and contributing to the formation of ground-level ozone and secondary organic aerosols. Existing formaldehyde data in Pakistan is inadequate, with limited studies on various occupational environments. Our study focused on the assessment of formaldehyde exposure to different occupational sites and evaluation of its resulting health impacts on workers who are considered as a potentially exposed or susceptible population (PESS). Samples from occupational workplaces like kindergarten, salons, resin art studio and other cottage industries were collected and analyzed through standard methods. QA/QC protocols were followed by performing percent recovery analysis along with spike and duplicate samples. Concentrations were found to be in range of ≤ 0.0084 and ≥ 0.102 ppmv. Statistical analysis was also performed on the collected data by using Minitab 20. The data showed a marked variation in exposure levels of different occupational sites. Calculated personal exposure levels of formaldehyde varied among the PESS. In some cases, concentration exceeded the OSHA permissible exposure limit (PEL), that is 0.75 ppm as an 8-hour time-weighted average (TWA), whereas PEL remained below the regulatory threshold in other occupational sites. Risk assessments were performed to evaluate health implications of respective workers. These results can be used to address and improve precautionary measure for the control of organic pollutants in urban atmosphere by policy makers.

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9AE.16

Linking Ambient and Personal PM2.5 Concentrations During a Pilot Study of Adolescents in the Chitwan Valley, Nepal.

ANDREW GRIESHOP, Jagriti Suneja, Stephanie Parsons, Krishna Shrestha, Ana Hernandez, Pamela Jagger, *North Carolina State University*

The Chitwan Valley, in the Terai (lowland) region of Nepal, is rapidly urbanizing. We conducted pilot data collection focusing on adolescents (age 8-15) in households adjacent to, but not part of, the Chitwan Valley Family Study (CVFS; a 29-year running demographic cohort study) to evaluate sensors and methods for personal exposure monitoring and evaluate long-term PM trends in the region. PurpleAir monitors were installed in three locations in Aug., 2021 and three more in March, 2023 to capture ambient $PM_{2.5}$ concentrations in urban and rural locations. The pilot exposure monitoring study (Sept., 2023 to Jan., 2024) resulted in 42 week-long personal exposure measures of adolescents (age 8-15). Personal PM exposure was measured with a portable sensor-based monitor (Atmotube Pro), in some cases paired with data-logging accelerometers to monitor wearing compliance. Atmotubes were collocated with the PurpleAir monitors and RTI MicroPEMs, which collect samples on Teflon filters, in a small subset of deployments. Analysis of accelerometer data suggests that sensors were worn for over an average of over 50% of the daytime hours (6am to 10pm, when motion would be expected), with no significant difference between younger (<12) and older (12-15) study participants or between genders and only 3 deployments without at least a full day worth of monitoring. Analysis of PM data filtered for 'non-compliance' periods showed no significant bias relative to full data sets in calculating average exposure. Mean (95% CI) average $PM_{2.5}$ exposures from uncorrected Atmotube data were 60.2 (52.5, 67.9) $\mu g\ m^{-3}$ with a marginally significant ($p=0.07$) 21% higher mean values among female participants. Ambient monitoring data indicate a moderate spatial variation in concentrations superimposed on a strong signature of regional seasonal trends with a 20-fold range in weekly average $PM_{2.5}$. Analysis of exposure and nearest ambient monitor data, multi-day variation in personal exposure, corrections based on collocations and evaluation of the potential contribution of household characteristics and indoor sources to exposures will be presented.

9AE.17

Multi-Year Assessment of PM2.5 and CO in Personal and Cooking Area Air Samples from Rwanda.

CLARA EICHLER, Joseph Pedit, Taran S. Dang, Ipsita Das, Karin Yeatts, Pamela Jagger, Sudhanshu Handa, Leena Nylander-French, *University of North Carolina at Chapel Hill*

Fine particulate matter ($PM_{2.5}$) and carbon monoxide (CO) are household air pollutants emitted from biomass burning for cooking and heating. $PM_{2.5}$ is associated with negative health impacts, including respiratory and cardiovascular disease, cancer, and systemic issues. CO is often used as $PM_{2.5}$ proxy in exposure assessments. We measured cooks' 24-hour personal exposure to $PM_{2.5}$ and CO in air in 300 households in Gisenyi, Rwanda, in 2015, 2016, 2017, and 2019. Air was sampled near the cooking area in a 110-household subset during the same 24 hours. Information on stove and fuel use and the cooking environment was collected. $PM_{2.5}$ concentrations were significantly ($p<0.05$) higher in cooking area air than in personal air and decreased over the study period in both sample types, coinciding with a shift from almost exclusive use of charcoal as primary cooking fuel to increased use of pellets and clean cooking fuels. However, while the shift to clean fuels was associated with a reduction of $PM_{2.5}$, fuel type alone did not explain the overall decrease of $PM_{2.5}$ that we observed. Correlations of $PM_{2.5}$ in personal and in cooking area air were weak to moderate (Spearman's rho: 0.15-0.52), indicating that personal exposure was influenced by factors other than cooking. Correlations of $PM_{2.5}$ with CO were weak to moderate for personal air (Spearman's rho: 0.16-0.48) and weak to strong for cooking area air (Spearman's rho: 0.13-0.79), with stronger correlations in later study years. CO levels also decreased over the course of the study, but to a lesser extent than $PM_{2.5}$. Our findings highlight the complexity of $PM_{2.5}$ and CO exposure from cookstove emissions and the limitations of using CO as a $PM_{2.5}$ proxy in exposure assessments. The significant differences between the sample types emphasize the need for personal air sampling to assess exposure to household air pollutants.

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9AE.18

Aerosol Pollution from Theatrical Fog and Haze Machines: Multi-Sensor PM2.5 Exposure Measurements for Public and Occupational Health. JINA WILDE, *The University of Texas at San Antonio*

Theatrical fog and haze, composed of aerosolized glycols and glycerin, are widely used in indoor entertainment venues such as theme parks and theaters. Despite vaporization mechanisms that are functionally identical to electronic cigarettes, these theatrical aerosols are consistently marketed as safe and non-toxic, resulting in a profound regulatory gap regarding indoor fine particulate matter (PM2.5) emissions. This study addresses this unacknowledged public health risk by quantifying the PM2.5 generation of standard theatrical atmospheric effects. Utilizing a controlled, sealed indoor testing environment, multiple consumer-grade optical air quality sensors (IQAir, PurpleAir, and Vevor) were deployed to measure the raw PM2.5 emissions of four commercial fog and haze machines with capacities ranging from 40 W to 1000 W. Across all machine capacities and fluid types, the aerosolization process rapidly generated dense, localized PM2.5 concentrations. All independent sensors consistently detected severe particulate elevations, rapidly exceeding the U.S. Environmental Protection Agency's (EPA) highest "Hazardous" threshold (≥225.5 μg/m³) and frequently driving the monitors to their maximum measurement limits of up to 5000 μg/m³. These physical mass concentrations far exceed modern health guidelines but remain legally permissible under outdated industry exposure limits that allow peak exposures of up to 40,000 μg/m³. The routine deployment of unmonitored theatrical fog machines in enclosed public spaces exposes vulnerable guests and entertainment professionals to extreme levels of unregulated particulate pollution. This research underscores the urgent need for comprehensive monitoring of PM2.5 and chemical pollutants—including formaldehyde and VOCs—alongside evidence-based indoor air quality policies that prioritize human health over industry allowances.

9AE.19

Characterizing Ultrafine Particle Gradients Across Greater Boston with a Network of CPCs. DAVID HAGAN, Abhay Vidwans, Emmie Le Roy, *QuantAQ, Inc.*

Air sensors and air sensor networks have become widely used for measuring criteria air pollutants such as $PM_{2.5}$, CO, NO_2, and O_3, providing the spatial density needed to characterize pollutant gradients and identify hotspots in communities that have historically been underserved by regulatory monitoring networks. Ultrafine particles (UFPs), while not currently regulated in the United States, are increasingly recognized as a major concern for human health, with mounting evidence linking UFP exposure to cardiovascular and respiratory outcomes. UFPs are rarely measured by routine monitoring networks due to the cost, power requirements, and operational complexity of conventional technologies. Recently, a lower-cost, lower-power water-based CPC developed by Aerosol Dynamics (Berkeley, CA) and integrated by QuantAQ into the MODULAIR-UFP platform has created an opportunity to expand UFP measurements into denser, network-style deployments. In this work, we present results from a summer 2026 field campaign in which five MODULAIR-UFP units were deployed across the greater Boston area, including QuantAQ's headquarters in Somerville, MA, and four sites operated by the Massachusetts Department of Environmental Protection (MassDEP). The campaign had two primary objectives: (1) to characterize the spatial and temporal heterogeneity of UFP concentrations across an urban-to-suburban gradient in a major U.S. metropolitan area, and (2) to evaluate the performance of the MODULAIR-UFP against co-located TSI 3783 reference CPCs at a subset of sites. We report on inter-site variability, diel and weekly concentration patterns, and the relationship between UFP concentrations and co-measured criteria pollutants, alongside MODULAIR-UFP performance metrics including accuracy, precision, and drift relative to the TSI 3783 reference. These results inform the use of lower-cost CPC networks for characterizing UFP exposure at the neighborhood scale and provide a framework for broader deployment of such networks by regulatory agencies and research groups.

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9AE.20

Estimating Associations Between Residential Air Pollution and Environmental Exposure on Acute Health Using Low-Cost Sensing Techniques. Danielle Wagner, Zachary Calhoun, Mark Wilson, Junfeng Zhang, David Carlson, Michael Bergin, LUCILLE GAGNON, *Duke University*

Exposure to air pollutants including PM2.5 and O3, as well as environmental conditions such as temperature and relative humidity, has been shown to have harmful effects on cardiovascular health and sleep quality. However, these stressors vary at spatiotemporal scales which cannot be captured by reference monitors, and the combined health effects of personal air pollution and environmental exposures are poorly understood. To quantify personal exposure, low-cost sensors have emerged as a promising option for developing dense observation networks. Additionally, wearable devices (such as the Oura ring) are a comfortable, technologically advanced method for assessing health metrics such as resting heart rate, heart rate variability, and sleep quality for extended periods in natural, at-home settings. Here, we deployed 13 indoor-outdoor pairs of low-cost sensors and Oura rings to participants in a pilot study across Durham, NC residences during July 2025 – August 2026. We also deployed passive sampling devices to characterize residential VOC exposures not captured by the low-cost sensors. Preliminary results show substantial variation of pollutants and environmental variables across Durham residences. Median hourly PM2.5 indoors was 18.9 µg/m3 during December – February (winter), compared with 12.9 µg/m3 in June – August (summer). During summer, median outdoor temperatures varied by 8°F across residences. On the hottest 10% of days, participants had modest increases in resting heart rate and decreases in heart rate variability and sleep quality. These results demonstrate substantial pollutant and environmental variabilities across residential environments within a single urban area, which may drive differences in cardiovascular and sleep outcomes. The preliminary findings highlight the importance of characterizing residential-scale variability in air pollution and heat exposure in relation to cardiovascular health and sleep quality. Ongoing analyses using additional data and more advanced statistical models will further quantify these relationships.

9AE.21

Source-Specific Wildfire PM2.5 Transport and Potential Exposure from a Satellite-Constrained Lagrangian Framework. YUE JIA, Ignacio Pisso, David Hyndman, *University of Texas at Dallas*

Satellite observations provide critical information on wildfire activity and smoke extent, but translating these measurements into near-surface particulate burden and population exposure remains challenging. We developed a satellite-constrained Lagrangian framework to quantify the transport and cumulative near-surface influence of PM2.5 emitted by the 2024 Smokehouse Creek Fire, the largest wildfire recorded in Texas.

Daily PM2.5 emissions were estimated by combining MODIS burned area with MODIS and VIIRS fire radiative power (FRP), including parameterizations for residual smoldering and active fires not represented in the burned-area product. The resulting emissions were transported with FLEXPART driven by hourly ERA5 meteorology. Time-integrated particle mass below 100 m above ground level was used to define a potential exposure index (PEI), while normalization by total emitted mass produced an event-specific transport efficiency metric. Model results were evaluated using MODIS imagery, OMPS aerosol index, and EPA surface observations, and were combined with population data to characterize spatial exposure patterns.

The hybrid inventory estimated that the Smokehouse Creek Fire emitted approximately 12.3 Gg of PM2.5 emissions during February 16-March 16, 2024. The modeled plume reproduced the observed northeastward transport axis and broad smoke extent on February 27. Modeled near-surface influence also captured the timing of elevated particulate matter at Oklahoma City, Amarillo, and Lubbock, although a shift of up to one day occurred at some sites. Cumulative burdens were greatest across western Texas and northern Oklahoma, while Dallas and Houston experienced substantially lower fire-specific influence. Population overlays further showed that the regulatory monitoring network did not fully sample areas of high modeled burden.

This framework links satellite-derived emissions, atmospheric transport, surface observations, and population distribution without interpreting total ambient PM2.5 as fire smoke. It provides an event-scale tool for diagnosing smoke transport, identifying monitoring gaps, and supporting source-specific aerosol exposure assessment.

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9AE.22

Transfer of Toxic Heavy Metals to the Aerosol Phase from the Tijuana River via Inductively Coupled Mass Spectrometry.
TOBIE BLOOM, Kimberly Prather, *University of California San Diego*

The Tijuana River (TR) is a binational watershed that has been impacted, for years, by millions of gallons of raw sewage, industrial pollution, and agricultural runoff which flows into the Pacific Ocean. A turbulent portion of the TR identified in a recent monitoring campaign, presents a unique risk to the San Diego South Bay (SDSB) region and its inhabitants due to enhanced production of river spray aerosol along with high levels of volatile organic compound (VOC) emissions. Past studies confirmed elevated levels of heavy metals in the river (aqueous phase). However, no investigations conducted have investigated heavy metals in the aerosol phase near the TR. To investigate the extent to which the community near the TR is being impacted by aerosols ejected by the river, we analyzed paired aerosol particulate matter (PM) filters and water samples using inductively coupled plasma-mass spectrometry (ICPMS) to understand fates and bioavailability of heavy metals in the aerosol phase. Measuring aerosolized heavy metal concentrations near the TR, will help elucidate the transfer of harmful pollutants into the community and determine whether these levels exceed regulatory thresholds for acute or chronic outdoor air exposure. Investigating the concentrations of aerosolized heavy metals and their similarities to aqueous concentrations, will allow us to evaluate the risk of heavy metals in polluted wastewater to nearby communities. This study will demonstrate the enrichment of heavy metals such as Zinc, Lead, Arsenic, Chromium and Cadmium occur in the liquid and the aerosol phase posing acute and chronic health impacts to surrounding communities.

9AE.23

Revealing the Invisibles: Ultrafine Particles, Urban Mobility, and Environmental Justice in São Paulo.
RUBENS PEREIRA, Maria de Fatima Andrade, *University of São Paulo*

Air pollution exposure in megacities is unevenly distributed and strongly associated with socioeconomic inequality. Ultrafine particles (UFP), despite their high toxicity and ability to penetrate deeply into the human body, remain largely unregulated and insufficiently monitored, particularly in socially vulnerable urban areas. This study investigates how São Paulo's socio-spatial segregation and mobility patterns contribute to differential exposure to submicrometer aerosols. The MEASURE-SP project employs a multi-scalar monitoring approach using the LUMIAR mobile laboratory equipped with high-resolution aerosol instrumentation, including SMPS, aethalometer, and ozone monitoring systems. Measurements will be conducted in socioeconomically vulnerable districts identified through mobility and social vulnerability indicators, including areas characterized by long commuting times and strong dependence on public transportation, as well as in urban background and regional atmospheric transition sites. Seasonal campaigns will investigate both primary emissions during winter and secondary aerosol formation processes during spring and summer. The project aims to quantify the "mobility-related exposure penalty" associated with forced urban mobility and environmental inequality, generating a high-resolution dataset on the spatial variability of UFP in the Global South megacity of São Paulo. The results are expected to support more equitable public policies related to air quality, transportation, and urban planning.

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9CA.1

Integrated Observation Modelling System for Real-Time Urban Air Quality, Noise and Traffic Assessment (INKA Project). KLEMEN KUNSTELJ, Matic Ivančič, Irena Ježek, Bálint Alföldy, Asta Gregorič, Martin Rigler, *Aerosol d.o.o.*

Urban environments are influenced by the combined effects of air pollution from traffic emissions and noise, both of which directly affect public health and quality of life. Traditional environmental monitoring systems often assess these components separately, limiting municipalities' ability to understand interactions or implement coordinated countermeasures. To address these limitations, within the INKA project, we developed an integrated observation–application model for the real-time evaluation of urban living quality indicators, demonstrated in a Slovenian city.

The INKA measurement network consists of a modular sensing platform including a Carbonaceous Aerosol Speciation System (CASS, TCA08 + AE36s) for high-time-resolution total carbon (TC) and black carbon (BC) measurements, an optical particle sizer (TSI), and a high-resolution sound measurement system. A cloud-based data infrastructure enables automated quality control, ensuring high-quality input data for the black carbon dispersion and acoustic models. A single urban living quality indicator derived from combined measurements is used for effective communication with the public and, at the same time, provides municipalities with a decision-support tool that raises awareness and supports targeted environmental management.

CASS provides near-real-time data on organic, elemental carbon, total carbon, brown and black carbon, and biomass-burning vs. fossil-fuel contributions to black carbon, with flexible sampling from 20 minutes to 24 hours. With no need for special gases or quartz components, CASS simplifies operation while delivering high-resolution data for air quality, climate, health, and emissions research. In this work, we will demonstrate the effects of air pollution across different areas and their different seasonal contributions.

9CA.2

Thermodenuder and Nd:YAG Laser Induced Charring of Biomass Burning Organic Aerosols. JOHN ALLEN, Ryan Poland, Ariana Deegan, Muhammad Abdurrahman, Mike Lesiak, Mac A. Callaham, Michael Caraway, Thomas Carroll, Joseph O'Brien, Rawad Saleh, Andrew Metcalf, Amanda Frossard, Geoffrey Smith, *University of Georgia*

The 2nd Georgia WIldland-fire Simulation Experiment (G-WISE 2) was a multidisciplinary campaign that studied combustion emissions from fuels collected at Ft. Stewart, Georgia with varying fuel-bed characteristics such as specific moisture content, fuel mass loading, and the inclusion of an organic-rich fuel known as duff. During G-WISE 2, a Single Particle Soot Photometer (SP2) sampled downstream of a thermodenuder heated at either 100°C or 300°C to evaporate organic coatings of varying volatility from black carbon (BC) particles. For experiments containing duff, the SP2 detected a larger concentration of BC particles when sampling through the thermodenuder compared to without it, indicative of charring of organic particles. The creation of charred, incandescing particles was facilitated in part by partial carbonization of the organic material in the thermodenuder and to a different extent, by the Nd:YAG laser in the SP2 itself – a phenomenon that has been observed with an SP2 previously with humic-like substances. Evidence for charring was also observed with a soot photometer aerosol mass spectrometer (SP-AMS), which detects refractory black carbon using a Nd:YAG laser. Although not downstream of the thermodenuder, the SP-AMS detected a substantially higher concentration of BC compared to offline measurements from an organic carbon and elemental carbon (OC/EC) analyzer for some of the burns as a result of laser-induced charring of organic aerosols. Here, we explore the charring process of biomass burning organic material either from laser-induced charring or thermodenuder assisted laser-induced charring using SP-AMS mass spectra to provide detailed chemical insight.

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9CA.3

Generation and Atmospheric Evolution of Light-Absorbing Carbonaceous Aerosol from Thermal Degradation of Plastic: From Deposited to Suspended Samples. ASMA SOOFI, Sithumi Liyanage, Christian Escritt, Katrina Betz, Jace Barton, Connor Karlik, Elijah Schnitzler, *Oklahoma State University*

Burning of waste plastics in open fires is common around the world, leading to emissions of aerosols containing carbonaceous components. Through atmospheric aging processes, light absorption and accordingly optical properties of these carbonaceous particles are altered. Here, oxidation and irradiation as two primary pathways responsible for atmospheric aging were studied. For generating carbonaceous aerosol, four colors (red, yellow, blue, and colorless) of polyethylene terephthalate glycol (PETG) were thermally degraded over a broad range of temperatures in a tube furnace, and the particles collected on filters. In general, higher masses were produced, from the same mass of PETG, at higher temperatures, and the highest temperature often led to flaming combustion, yielding elemental, black carbon aerosol. Infrared spectroscopy was used to characterize the particle composition, and visible spectroscopy for the absorption. The organic aerosols included polymer and non-polymer species, which depend on the temperature at which particles were collected. Selected samples were irradiated in a solar simulator and oxidized in a flow tube with ozone at 50 ppb. The absorption of particles decreased more through irradiation compared to ozone oxidation. After the first day of irradiation, a 50% decrease in absorption of samples from both red and yellow PETG was observed. Infrared spectra may exhibit features of new oxygenated groups at the particle surface. These results show that upon entering the atmosphere nanoparticles generated from plastic pollution will have dynamic impacts on air quality and climate. In ongoing work, we are exploring the lifetime of light-absorbing organic aerosol from plastic burning for suspended particles in a smog chamber.

9CA.4

Orthogonal Analytical Approaches for Elucidating Structure-Optical Property Relationships in Brown Carbon. STEPHANIE GONZALEZ, Alexi Allen, Daniel B. Curtis, Paula K. Hudson, *California State University, Fullerton*

Brown carbon (BrC) aerosol particles represent a specific category of atmospheric organic aerosols (OA) that contain chromophores which absorb light radiation in the near-ultraviolet (UV) and visible wavelength ranges. The absorption and emission of solar and terrestrial radiation by BrC directly affect climate, thus making it a significant component of the global radiative balance. The contribution of BrC to light absorption by climate models is challenging given their complex chemical composition. This study aims to investigate the light absorption characteristics and chemical composition of well-established BrC chromophores (standards), including 1-, 2-, and 4-methylimidazole, 1,2-dimethylimidazole, pyrazine, pyrrole, and N-methylpyrrole, as well as laboratory-generated BrC mixtures through the reaction of dicarbonyls with amino acids. UV-Vis spectrophotometry provided absorption of individual chromophores and bulk BrC mixture products. Individual chromophores absorbed light in the UV region, while BrC mixtures absorbed light in the UV and visible regions. Comparable aerosol measurements were conducted using an aethalometer, a filter-based instrument to measure the concentration of light-absorbing carbonaceous particles. Ultra-performance liquid chromatography combined with high-resolution mass spectrometry (UPLC-HRMS) provided the composition for individual BrC compounds including structural information using MS2 and absorption using a diode array detector. MS2 fragmentation patterns revealed an -HCN loss in methylimidazoles, pyrazine and N-methylpyrrole. Nuclear magnetic resonance (NMR) measurements offered structural and functional group details regarding the BrC chromophores and mixtures. Collectively, these orthogonal measurement techniques will shed light on connections between climate-relevant light absorbing properties and individual BrC chromophores, thereby enhancing the overall characterization of brown carbon. The outcomes of this study are expected to mitigate uncertainties related to BrC within climate models, significantly improving our understanding of its impacts on climate.

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9CA.5

The Role of Wood Burning for Heating on Urban Air Quality. BENJAMIN A. NAULT, Nahin Ferdousi-Rokib, Salvatore Milletich, Ayreanna Pettijohn, Keelie N. Steiner, Kirsten Koehler, Benjamin Zaitchik, Peter F. DeCarlo, *Johns Hopkins University*

Current U.S. regulations for annual $PM_{2.5}$ is 9 µg m^{-3} while W.H.O. recommends that annual $PM_{2.5}$ should not exceed 5 µg m^{-3}. As increasing temperatures and influence of wildfires are increasing $PM_{2.5}$ mass concentrations during summer periods, identifying and reducing other sources of $PM_{2.5}$ concentrations to reduce annual concentrations is imperative. One of these other sources is wood burning for heating. Here, we use a combination of long-term regulator observations, a low-cost monitoring network, and an air quality monitoring supersite that is part of the DOE Baltimore Social-Environmental Collaborative, to investigate the role of wood burning heating in the Baltimore region and its impact towards the area's annual $PM_{2.5}$ mass concentration. We find that between late fall to early spring (~November - ~March), there is a comparable amount of total $PM_{2.5}$ mass concentration as there is during summer. However, unlike summer, where the majority of the $PM_{2.5}$ originates from the photochemical production of secondary organic aerosol, organic aerosol only composes ~50% of the total $PM_{2.5}$ during these colder periods. Furthermore, most of the organic aerosol is primary, originating from biomass burning, as identified with positive matrix factorization with an aerosol chemical speciation monitor and also confirmed with results collected from an aethalometer. Spatially, the impact of this wood burning is explored with the low-cost sensors, demonstrating mixed results in the impact of this wood burning aerosol that is highly dependent on meteorological conditions. We will explore the potential impact in best case scenario eliminating wood burning both at the urban level and neighborhood level. The results will be placed into the context of monthly $PM_{2.5}$ trends observed in other cool-to-cold climate urban areas in the U.S. to provide potential context in what other urban areas can do to reduce $PM_{2.5}$.

9CA.6

A Method to Retrieve the Imaginary Refractive Index (k) of Brown Carbon Incorporating Measurements of Black Carbon and Particle Coating Thickness. ELIZABETH WINTER, Dayton Maglich, John Allen, Ryan Poland, Muhammad Abdurrahman, Mike Lesiak, Mac A. Callaham, Michael Caraway, Thomas Carroll, Joseph O'Brien, Rawad Saleh, Andrew Metcalf, Geoffrey Smith, *University of Georgia*

Biomass burning is a substantial source of atmospheric brown carbon (BrC) that has light absorption properties, often quantified using the imaginary refractive index (*k*), that vary substantially based on combustion conditions. Estimation of BrC *k* values in biomass burning aerosol is complicated by the concomitant release of more-strongly absorbing black carbon (BC). Partitioning of light absorption to BrC and BC is also affected by the presence of organic coatings on BC particles, which can enhance BC light absorption. Traditionally, models used to retrieve BrC *k* values make assumptions about the mixing state of BC and BrC including: assuming no internal mixing, estimating maximum coating thickness constrained by the total aerosol size distribution (SMPS), or by using measured absorption enhancement to derive coating thickness from Mie theory. Here, we present a new optical closure method to retrieve BrC *k* values that uses BC concentration and coating thickness measured with a single particle soot photometer (SP2) combined with total aerosol absorption from a four-wavelength photoacoustic spectrometer. The BrC absorption spectrum is parameterized with a power law functional form yielding a measure of absorption strength, *k*550 (the value of *k* at 550 nm), and a measure of wavelength dependence, *w*. We use this method with smoke aerosol generated during the second iteration of the Georgia WIldland-Fire Simulation Experiment (G-WISE 2) campaign and find that values of both BrC *k*550 and *w* tend to be systematically lower than when using the other models that do not incorporate measurements of coating thickness. We also observe that *k*550 tends to be smaller and *w* tends to be larger for burns that are dominated by smoldering conditions (*k*550 = 0.0006 – 0.0009, *w* = 2.8 – 4.2) compared to those that are dominated by flaming conditions (*k*550 = 0.004 – 0.011, *w* = 0.3 – 0.8).

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9CA.7

High Levels of Black and Brown Carbon Particulate Matter near a Wood Pellet and Biochar Production Facility in Southern Georgia. ROBY GREENWALD, Nadia Alhadidi, Treva Gear, *Georgia State University*

From July-September 2025, we operated air quality sensors in a residential area of Lumber City, Georgia, 300m from the fenceline of a wood pellet and biochar manufacturing facility. We included optical sensors for $PM_{2.5}$, a multi-wavelength aethalometer for black carbon (BC) and brown carbon (BrC), and devices for measuring meteorological conditions (temperature, relative humidity, wind speed and direction, precipitation). Examination of time series data revealed an unmistakable pattern: the BC levels would increase by an order of magnitude each morning beginning around 6:30 am and remain elevated for 2-3 hours. During this 3-month sampling period, mean BC 7-9 am was 1.6 $\mu g/m^3$ compared to 0.18 $\mu g/m^3$ the rest of the day. The peak 1-hour BC was 9.5 $\mu g/m^3$. Baseline and peak levels varied with meteorology, but there was no identifiable day of week pattern. For comparison, we conducted concurrent measurements alongside the busiest highway in Georgia (I-75/85 in Midtown Atlanta). During the same July-September time period, the mean BC in Atlanta 7-9 am was 0.73 $\mu g/m^3$ with a maximum of 2.3 $\mu g/m^3$). BrC for Lumber City also showed a consistent diurnal pattern with mean BrC 7 pm-2 am of 170 ng/m^3 compared to 67 ng/m^3 the rest of the day. There is no known natural phenomenon that would produce these elevated BC and BrC levels with such consistent time of day patterns, suggesting the presence of a nearby anthropogenic source. These results show that residents of this low-income, rural community are exposed on a daily basis to higher levels of BC and BrC than is found directly adjacent to the most intense source of traffic emissions in the State of Georgia.

9CA.8

What Data from Airborne, Long Term Filter-Based, and New Real-Time Ground-Based Networks Can Tell Us About the Variability of Brown and Black Carbon Aerosol Absorption in Remote Regions of the United States. KATE KWASNICK, Anna Robertson, Yingjie Shen, Elena Goodspeed, Roya Bahreini, Sean Raffuse, Ann M. Dillner, Armistead G. Russell, Nga Lee Ng, Shane Murphy, *University of Wyoming*

There continues to be significant uncertainty surrounding light absorption from aerosol particles containing black and brown carbon. A significant fraction of this uncertainty stems from the wide range of instrumentation and differing analysis approaches used to quantify absorption from black and brown carbon. Additional uncertainty stems from poor quantification of the effects of chemical aging on black and brown carbon absorption. In this talk, we will present analysis of airborne campaigns (WE-CAN, FIREX), long established ground based networks (IMPROVE), and the relatively new ground-based network ASCENT (Atmospheric Science and Chemistry Measurement Network). Our analysis will focus on biomass burning events given their outsized impact. We will present the range of mass absorption coefficients determined from the various networks and campaigns and discuss what fraction of this range is due to instrumental uncertainty versus actual differences caused by aging, altitude, temperature, etc. We will show how newly available aerosol chemical speciation monitor (ACSM) and scanning mobility particle sizing (SMPS) data from the ASCENT network informs the aging and coating thickness of biomass burning plumes and how this new knowledge gives us better understanding of IMPROVE data. Finally, we will summarize what all of this data tells us about brown carbon bleaching and if it is mainly driven by evaporation of organic aerosol mass or if it is caused by chemical changes altering the refractive index of the organic aerosol.

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9CA.9

Quantifying Source-Specific Optical Properties and Associated Uncertainties of Carbonaceous Aerosols from Biomass Burning in the Indo-Gangetic Plain, India. ROSHAN KUMAR SINGH, Indra Mohan Nigam, Seema Prajapati, Shakiba Talebian, Antonio Mirante, Jason S. Olfert, Joel Corbin, Tarun Gupta, Ran Zhao, *University of Alberta, Canada and IIT Kanpur, India*

Despite extensive advances in aerosol optics, most knowledge on biomass burning fine particulate matter ($PM_{2.5}$) is derived from studies of European boreal and North American fuels, leaving substantial gaps in understanding emissions from region-specific household biofuels in the Indo-Gangetic Plain (IGP). This limitation is critical, as the IGP represents one of the most polluted regions globally, where biomass combustion remains a dominant primary source of atmospheric particles. Addressing this gap requires source-specific characterization of optical properties. In this study, we systematically investigate the optical behaviour of carbonaceous $PM_{2.5}$, emitted from 25 regionally relevant biomass fuels collected across the central IGP, India. Controlled laboratory combustion experiments were performed to generate emissions under reproducible conditions. Light absorption properties were quantified for both black carbon and brown carbon, including mass absorption cross-section and spectral dependence. A key focus of this work is the reconciliation of discrepancies between real-time (online) and filter-based (offline) measurement approaches, which remain a major source of uncertainty in aerosol optical characterization. By directly comparing these techniques, we provide insights into methodological biases and their implications for interpreting light-absorbing aerosol properties. Our findings refine the current understanding of biomass burning aerosol optics by incorporating underrepresented fuel types and addressing methodological inconsistencies. These results have important implications for improving source-resolved radiative forcing estimates, reducing uncertainties in aerosol optical parameterizations, and enhancing the representation of biomass burning emissions in regional and global climate models, particularly for South Asia.

9CA.10

Case Study: Influence of Rain on Land-Atmosphere Interactions Through Changes in Near-Surface Aerosol Composition and Physicochemical Properties. ZEZHEN CHENG, Meghan C. Guagenti, Sining Niu, Ashfiqur Rahman, Matthew A. Marcus, Kyounglim Kang, Jing Li, Nurun Nahar Lata, Chongai Kuang, Gregory W. Vandergrift, Swarup China, *Pacific Northwest National Laboratory*

Land–atmosphere interactions can modify aerosol concentration, composition, and properties through a variety of physical and chemical processes. In turn, atmospheric aerosols can deposit on soils, altering soil chemical composition and biogeochemical processes. However, observations targeting these interactions remain limited, hindering their accurate representation in Earth system models. To address this gap, we are conducting the Atmospheric Radiation Measurement (ARM) MONet (Molecular Observation Network) TAP (Terrestrial–Atmospheric Processes) campaign at the ARM Bankhead National Forest (BNF) site to collect near-surface aerosol samples. Using the automated MONet Atmospheric Program Sampler (MAPS), we collected size-resolved aerosol samples with two-stage cascade impactors having 50% aerodynamic cutoff diameters of 620 nm (Stage B) and 120 nm (Stage D), volatile organic compounds samples using sorbent tubes, and bulk aerosol filter samples for offline chemical and ice nucleation analysis. This case study focuses on samples collected from September 23–26, 2025, during a period of frequent daily rainfall. Samples were collected before and after rainfall to investigate how rainfall influences land–atmosphere interactions through changes in near-surface aerosol composition and physicochemical properties. Stage D samples were analyzed at EMSL using computer-controlled scanning electron microscopy with energy-dispersive X-ray spectroscopy (CCSEM-EDX) to characterize individual particle morphology and elemental composition for particle-type classification. We also applied scanning transmission X-ray microscopy with near-edge X-ray absorption fine structure spectroscopy (STXM/NEXAFS) at the Advanced Light Source (ALS) to examine carbon functional groups and carbon speciation within individual particles. In addition, organic compounds were analyzed using nanospray desorption electrospray ionization high-resolution mass spectrometry (nano-DESI-HRMS) to determine molecular formulas and derive chemical metrics, including oxidation state, modified aromaticity index, double-bond equivalent, and volatility. By integrating these offline measurements with ARM meteorological and online aerosol observations, we aim to improve understanding of how rainfall influences land–atmosphere interactions and alters aerosol composition and properties. These results will help reduce uncertainties in E3SM related to land–atmosphere interactions.

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9CA.11

Optical Properties Along the Nanochar Continuum. TIMOTHY SIPKENS, Alireza Moallemi, Rym Mehri, Jalal Norooz Oliaee, Joel Corbin, *National Research Council Canada*

In this work, we discuss nanochar, aerosols originating from small droplets of organic material that carbonize and graphitize to become highly light absorbing. The term unifies several terms in the literature – tarballs, dark brown carbon, grey carbon, brown amorphous carbon spheres, etc. – under a common umbrella, offering generalization and harmonization of terminology. These particles arise from both anthropogenic (marine emissions) and natural (wildfires) sources, where organic material does not completely vaporize in a combustion process. Like soot, these particles exist across a continuum of properties, from immature brown carbon to mature black carbon. However, unlike soot, which exists nearly universally in the mature state upon release into the atmosphere, nanochar can exist across much of this continuum. To explore the properties of nanochar, particles are generated from pyrolysis oil in the laboratory. Heat treatment allows for realizing particles across the continuum, where we characterize their properties, noting differences relative to young and mature soot. While several properties will be noted, a focus is placed on the optical properties measured using a novel photothermal interferometer, paired with a supercontinuum laser source to span the visible spectrum. We pair this with a reformulation of Tauc's model, discussing whether this model is sufficient to describe trends in the optical properties of both nanochar and soot across their respective continua, despite some underlying weaknesses.

9CA.13

Beyond $PM_{2.5}$: How Black Carbon Measurements Reveal Air Pollution Patterns and Sources. JACK KODROS, David Lu, *Clarity Movement Co.*

While $PM_{2.5}$ has long served as the primary metric for assessing air pollution exposure, understanding what drives those concentrations requires going deeper into the composition of fine particulate matter. Black carbon (BC), an air pollutant produced by incomplete combustion, offers a unique lens into pollution sources linked to traffic, industry, and biomass burning, while also carrying strong implications for both human health and climate forcing.

This presentation explores how the latest generation of low-cost BC sensors is expanding the capabilities of particulate monitoring networks worldwide. Clarity's Black Carbon Module integrates seamlessly with existing air quality measurement networks to measure BC in real time, achieving strong correlation with reference-grade aethalometers (R^2 greater than 0.8) while maintaining the affordability and scalability needed for dense network deployment.

Drawing from deployments in multiple regions, including the RAC WA Air Health Monitor in Perth, Australia, and Brightline Defense's community network in San Francisco, California, this session will showcase how BC measurements uncover distinct spatial and temporal patterns that $PM_{2.5}$ data alone cannot capture. These include elevated concentrations near traffic corridors, community-level disparities in exposure, and clear signatures distinguishing fossil fuel from biomass combustion sources.

By combining BC data with meteorological and emissions information, cities and researchers can better pinpoint pollution sources, design targeted interventions, and evaluate the impact of clean transportation and heating measures. The session will share representative case studies from each deployment region, discuss calibration approaches and quality assurance procedures used to maintain comparability with reference instruments over multi-month operation, and outline practical lessons for integrating low-cost BC sensors into existing $PM_{2.5}$ networks. These results mark an important step forward in the practical application of low-cost sensor technology for urban air quality management and source attribution.

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9CA.14

Comparison of Carbonaceous Aerosols and PAHs During Smoke-Free and Smoke-Impacted Periods in Northern Nevada. VERA SAMBUROVA, Chiranjivi Bhattarai, Siying Lu, Andrey Khlystov, *Desert Research Institute*

In 2020, several wildfires in the western United States (US) impacted Nevada area for weeks, affecting regional air quality. To assess the contribution of wildfire smoke to air quality in the Reno–Sparks (Nevada) area, air pollutants were measured and analyzed during a smoke-free period (August–October 2019) and compared with those measured during a smoke-impacted period (August–October 2020). Ambient concentrations of fine particulate matter ($PM_{2.5}$), organic carbon (OC), and elemental carbon (EC) measured at the U.S. Environmental Protection Agency (EPA) monitoring station in the Reno–Sparks area during smoke-affected days were approximately 8–9.6 times higher than during smoke-free days, whereas O_3 concentrations increased by only ~12% during fire-affected days.

We found that on 18 of the 50 smoke-affected days, $PM_{2.5}$ concentrations exceeded the primary 24-hour U.S. EPA National Ambient Air Quality Standard (35 μg m^{-3}). During both the smoke-free and smoke-impacted periods, filter samples and XAD-resin cartridges were collected for the analysis of PAHs in the particle and gas phases, respectively. $PM_{2.5}$-bound PAHs were collected on filters over 24-hour periods, extracted, and quantitatively analyzed for 104 PAHs using Gas Chromatography–Mass Spectrometry (GC-MS). We found that total $PM_{2.5}$-bound PAH concentrations were ~6.3 times higher during smoke-affected days than during smoke-free days, with dimethylnaphthalenes (1.4-, 1.5-, and 2,3-dimethylnaphthalenes) dominating the smoke-affected $PM_{2.5}$ samples.

Analysis of gas-phase PAHs in smoke-affected samples showed that the total concentration of gas-phase PAHs was about 47 times higher than that of $PM_{2.5}$-bound PAHs, with naphthalene being the most abundant gas-phase PAH. These findings highlight the importance of measuring and regulating gas-phase PAHs in ambient air.

9CA.17

Plastic Rain in Florida. JASON WATERS, Alison Bain, *Oregon State University*

Micro- and nanoplastics have been shown to be susceptible to atmospheric transport and deposition. As global plastic production has far outpaced treatment and recycling of plastic materials, and with production expected to more than double in the next 20 years, there is a need for understanding sources, movement, and fate of microplastic particles (MPs) in the environment. Sources of MPs in the atmosphere include agricultural dust, car tire and brake wear, and potentially the incineration or combustion of plastic products. Depending on their size, MPs can move and deposit in remote areas a considerable distance from their source. As knowledge of MP pollution becomes more widespread, communities are becoming increasingly concerned with potential effects and sources of MPs.

A concerned citizen collected suspected plastic debris in Fort Lauderdale, Florida, after a severe rainfall event left their backyard covered in an unknown white material, which they were concerned came from a nearby waste-to-energy (WTE) site. First, the suspected plastic samples were separated and sized with optical microscopy. Next, they were analyzed with attenuated total reflectance infrared (ATR-IR) spectroscopy, Raman spectroscopy, and scanning electron microscopy-energy dispersive spectroscopy (SEM-EDS) to determine elemental and structural information. Solvent compatibility testing was then conducted to determine the approximate family of polymer present. The samples appear to be heavily oxidized, consistent with potential combustion, pyrolysis, and oxidation via UV radiation, and lack heteroatoms such as sulfur, silicon, nitrogen, or halogens. Finally, 10-hour backwards forecasts of particle trajectory were computed with NOAA's HYSPLIT model at multiple elevations, which found likely trajectories passing over the nearest WTE sites to the sampling location. There are eleven such WTE sites in Florida, including four within 40 miles of the sampling location and one within 10 miles, with an estimated combined capacity of approximately 8000 tons of trash per day.

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9CA.18

Preferential Association of Refractory Black Carbon with Biomass-Burning and Secondary Organic Aerosol: A Probe of Urban BC Mixing State. JIHYE MOON, Hwajin Kim, *Seoul National University*

Black carbon (BC) is the strongest light-absorbing aerosol, yet its warming is governed less by BC abundance than by the material with which it is internally mixed. Conventional aerosol mass spectrometry resolves organic aerosol (OA) sources but is blind to refractory BC (rBC), and therefore cannot reveal which OA sources actually coat BC. Using a soot-particle aerosol mass spectrometer (SP-AMS) at an urban Seoul site during January–February 2026, we detected rBC carbon-cluster ions ($C1^+$–$C5^+$) alongside non-refractory species and applied positive matrix factorization (PMF) jointly to organic and refractory-carbon fragments, apportioning rBC mass among its associated OA sources.

Five OA factors were resolved (MO-OOA, LO-OOA, HOA, COA, BBOA). Although aged more-oxidized OOA (MO-OOA) dominated OA mass (37%), it carried only 16% of rBC, whereas biomass-burning (BBOA) and less-oxidized secondary (LO-OOA) OA together held 59% of rBC from just 37% of OA mass. Expressed as an enrichment factor ε = f(rBC)/f(OA), rBC was enriched in LO-OOA (1.7), BBOA (1.6), and traffic-related HOA (1.4) but depleted in MO-OOA (0.4). Consistently, rBC coatings were less oxidized than bulk OA (mass-weighted O/C 0.62 vs 0.70), and the rBC carbon-cluster ions were biomass-dominated (BBOA:HOA =~ 1.8), unlike the traffic-dominated soot reported for tropical cities.

Together, these metrics indicate that urban BC mixing state is controlled by co-emission and early condensation rather than regional aging: rBC is internally mixed with locally emitted (biomass, traffic) and freshly processed organics, whereas the aged regional OOA pool is largely externally mixed. The resulting thick, moderately oxidized coatings are expected to amplify absorption through the lensing effect. Refractory-carbon-informed PMF thus turns a bulk mass spectrometer into a source-resolved probe of BC mixing state and aging that organic-only apportionment cannot provide.

9CA.19

Black Carbon Variability in Semi-Urban Traffic Environments of India: Insights from Real-Time Monsoon Monitoring. ISHITA SHARAN SRIVASTAVA, Aditya Kumar Patra, Brandon E. Boor, Nusrat Jung, *Indian Institute of Technology Kharagpur*

Black carbon (BC) is an important indicator of traffic-related air pollution and a contributor to atmospheric warming. Although BC has been extensively studied in major urban centers, information from semi-urban environments remains limited. This study investigated real-time BC variability across three contrasting microenvironments representing high-density traffic (HDT), low-density traffic (LDT), and background (BG) conditions during the monsoon season in eastern India. Continuous measurements were conducted using a portable MA350 micro-aethalometer, supported by simultaneous traffic observations, vehicle classification, and meteorological monitoring. Distinct spatial differences were observed among monitoring locations. Mean BC concentrations were highest at the HDT site (4.09 ± 6.01 µg m-3), followed by LDT (1.47 ± 0.63 µg m-3) and BG (0.90 ± 0.17 µg m-3). Short-duration peaks exceeding 40 µg m-3 were recorded at the highway site, indicating strong influence of heavy-duty vehicle emissions despite enhanced atmospheric dispersion and wet scavenging during the monsoon season. Diurnal patterns showed elevated concentrations during periods of increased traffic activity, whereas the background site exhibited relatively stable conditions throughout the day. Traffic counts and fleet composition analysis revealed that BC variability was more strongly associated with heavy-duty vehicle activity, vehicle idling, and congestion-related emission events than with total traffic volume alone. Wind-rose analysis at the HDT site revealed dominant wind sectors aligned with the flyover corridor, suggesting directional transport of traffic-related emissions toward the monitoring location. Multiple linear regression analysis showed limited predictive capability at the traffic-dominated site, indicating that short-term BC variability was governed primarily by local emission events rather than meteorological factors. Monsoon conditions reduced regional background BC concentrations, allowing local traffic emission events, particularly those associated with heavy-duty vehicles, to be identified more clearly. These findings demonstrate substantial microenvironmental contrasts in BC exposure and emphasize that emission characteristics outweigh traffic volume in determining BC variability in semi-urban traffic environments.

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9CA.20

Year-Long Online Quantification and Source Apportionment of Brown Carbon in Atlanta, Georgia. SOYOUN GWAK, Sohyeon Jeon, Matic Ivančič, Gašper Lavrič, Ruizhe Liu, Longkun He, Pengfei Liu, Asta Gregorič, Martin Rigler, Varun Yadav, Nga Lee Ng, *Georgia Institute of Technology*

Carbonaceous aerosol is a major component of atmospheric fine particulate matter (PM2.5) and is commonly categorized into two components: black carbon (BC), which absorbs solar radiation and warms the climate, and organic carbon (OC), which scatters sunlight and induces cooling. Brown carbon (BrC) is the light-absorbing fraction of organic aerosol and is emitted directly from combustion sources such as biomass burning and fossil fuel combustion or formed secondarily through atmospheric oxidation of volatile organic compounds (VOCs). Although the southeastern United States, particularly Atlanta, has been the focus of extensive research on organic aerosol because of its abundant biogenic emissions, long-term observational studies of BrC remain limited, with most relying on filter-based analyses or short-term online measurements. To address this gap, we conducted continuous online measurements of BC and total carbon (TC) over a one-year period (April 2025-April 2026) at the Atlanta, Georgia site in the Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT). Utilizing a dual-instrument approach with an Aethalometer (AE33) and a Total Carbon Analyzer (TCA09), we evaluated the abundance of BrC from multi-wavelength absorption measurements, including the relative importance of primary and secondary BrC, as well as fossil fuel and biomass-burning contributions. Through evaluation of seasonal, diurnal, and weekday-weekend variations in BrC abundance, this study provides new high-resolution insights into the source and temporal variability of BrC in the urban southeastern United States.

9CA.21

Effects of Atmospheric Aging on the Optical Properties of Biomass Burning Aerosols from Simulated Wildland Fires. DAYTON MAGLICH, Elizabeth Winter, John Allen, Ryan Poland, Muhammad Abdurrahman, Michael Caraway, Thomas Carroll, Mike Lesiak, Mac A. Callaham, Joseph O'Brien, Andrew Metcalf, Rawad Saleh, Geoffrey Smith, *University of Georgia*

Wildland Fires are major sources of carbonaceous aerosols, which can influence Earth's climate by altering the radiative balance through their ability to absorb and scatter light. Carbonaceous aerosols can also undergo photolytic or photochemical aging in the atmosphere, which can change their optical properties. Given the complexity of aging, a more complete understanding will help improve how they are treated in climate models. As part of the second iteration of the Georgia Wildland-Fire Simulation experiments (G-WISE-2), we investigated the effect of aging on the optical properties of carbonaceous aerosols from combustion of fuel beds representative of Southeastern U.S. forests. The fuel beds used in this experiment were either composed entirely of surface fuels or of surface fuels and duff and were conditioned to high (70%) and low (10%) moisture levels. The combustion took place in a 1000 m^3 burn room, and the fresh smoke was transferred to a 7.5 m^3 Teflon chamber located outdoors, where it was aged under natural sunlight for approximately five hours. To examine the evolution of the optical properties of carbonaceous aerosols, we used a four-wavelength (406, 532, 663, 786 nm) photoacoustic spectrometer (PAS) to measure absorption and a single particle soot photometer (SP2) to measure refractory black carbon concentration. In all experiments, we normalized PAS absorption to the refractory black carbon concentration from the SP2 and observed at least a 25% decrease in absorption at all wavelengths, suggesting that the optical properties of carbonaceous aerosols from biomass burning can be rapidly altered once emitted into the atmosphere.

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9CA.22

Quantitatively Constraining Organic Aerosol Oxidation Pathways with Triple Oxygen Isotopes. DANIEL CROCKER, Heejeong Kim, Emily Doi, Matthew Goss, Meredith Hastings, David Johnston, *Harvard University*

Organic aerosols (OA) are a major source of uncertainty in assessing aerosol impacts on atmospheric composition and climate. Atmospheric oxidation governs OA formation and aging, yet the relative contributions of different oxidation pathways remain underconstrained by direct observations. Here, we present year-long triple oxygen isotope ($\delta'^{18}O$, $\Delta'^{17}O$) measurements targeting the organic matter in atmospheric OA samples. These isotopic data reveal that the OA contains mass-independent oxygen and indicate contributions from multiple oxidants involved in OA oxidation, including O_2 (via radical-initiated chemistry), O_3, and OH. Combining these oxidants with empirical and observational constraints on their isotopic compositions, we employ an isotope-based mixing model with Monte Carlo resampling to deliver quantitative, observation-based constraints on oxidant-specific contributions to atmospheric OA formation. The resulting oxidant contributions support a dominant role for radical-initiated chemistry accompanied by O_2-derived oxygen incorporation, along with persistent, but minor, contributions from ozonolysis and OH addition reactions. These findings are broadly consistent with independent model predictions of OA formation pathways, demonstrating that triple oxygen isotopes provide a powerful, quantitative tracer for OA oxidation pathways and a new observational framework for externally validating and improving representations of OA atmospheric chemistry.

9CA.23

What Do the Trends in AAE at the ASCENT Rubidoux Site Tell Us? EMILY BERMUDEZ, Tiffany Hu, Erin Bowey, Yumeng Cui, Gino Pena, Bradley Ries, Armistead G. Russell, Ann M. Dillner, Sean Raffuse, Nga Lee Ng, Roya Bahreini, *University of California, Riverside*

Black carbon (BC) and brown carbon (BrC) are both light-absorbing aerosol components; however, their absorption differs in its wavelength dependence, which is quantified by the Absorption Ångström Exponent (AAE). BC, produced by incomplete combustion, typically exhibits an AAE near 1, whereas BrC, which can be emitted directly or formed through secondary atmospheric processes, exhibits higher AAE values. The divergence between these values allows AAE to indicate the relative contribution of BC versus BrC to aerosol absorption. This study analyzes 20 months (May 2023 - December 2024) of hourly equivalent BC (eBC) measurements from an AE33 aethalometer, with a PM2.5 inlet, at the Rubidoux ASCENT site in Riverside, CA, converting eBC concentrations at seven wavelengths (370-950 nm) to absorption coefficients using wavelength-specific mass absorption cross sections. AAE was calculated as the slope of a power-law fit to absorption coefficients across all seven wavelengths, then compared across seasons, weekdays versus weekends, and hours of the day. AAE was significantly higher in winter than in other seasons (Kruskal-Wallis $p<0.001$) and on weekends than weekdays (Mann-Whitney U $p<0.001$) across all seasons, with the largest weekday/weekend difference occurring in winter, consistent with a greater relative contribution of BrC during these periods. Diurnally, AAE reached a minimum near 7:00–10:00 am local time, consistent with BC from traffic emissions dominating absorption during the morning rush hour, and increased through the evening and overnight hours, suggesting a higher contribution from BrC overnight. Future work will examine whether the diurnal AAE pattern holds consistently across seasons, and assess the relative role of primary emissions versus secondary formation of BrC.

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9CA.24

Predicting Functional Groups from TOF-ACSM Mass Spectra Using Elastic Net Models for ASCENT Sites. NA MAO, Manjula Canagaratna, Satoshi Takahama, Nga Lee Ng, Seonsik Yun, Douglas A. Day, Jose-Luis Jimenez, Ruizhe Liu, Haroula D. Baliaka, Ryan Ward, Purushottam Kumar, Richard Flagan, Nicolas A. Buchenau, Cade Christensen, Jason Surratt, Ann M. Dillner, *University of California, Davis*

The Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT) provides high time resolution measurements of aerosol composition using Time of Flight Aerosol Chemical Speciation Monitors (ToF-ACSM), but its chemical interpretation of organic aerosol (OA) remains limited. To enhance the chemical resolution of ACSM measurements, this study develops statistical models to predict organic functional groups from ACSM mass spectra using collocated Fourier Transform Infrared (FTIR) measurements. We focus on ASCENT sites with diverse source influences, including Denver (urban), Look Rock (rural), and Pico Rivera (urban/industrial). Elastic Net (EN) regression models are developed using key ACSM fragment ions (m/z 29, 43, 44, 55, 57, 60, 69, 71, and 73) to predict functional groups, including carboxylic acids (COOH), alcohols (aOH), non-acid carbonyls (naCO), and alkane CH groups (aCH). Model performance is evaluated against collocated ambient FTIR-derived functional group measurements and compared with linear regressions for single m/z. Across all sites, EN models outperform simpler linear methods, yielding improved predictive accuracy and reduced bias by capturing multivariate relationships among fragment ions. Model performance varies by site, reflecting differences in source contributions and atmospheric processing, but overall demonstrates that EN-based approaches provide robust and transferable predictions of functional group composition. Application of the models to hourly ACSM data revealed distinct seasonal and diurnal variability in functional group distributions across all three sites. These results demonstrate that Elastic Net models can significantly enhance the chemical interpretability of ACSM measurements, enabling high time resolution characterization of organic aerosol composition across ASCENT sites.

9CA.25

Shifting Black Carbon Trends in the Los Angeles Basin. TIFFANY HU, Erin Bowey, Yumeng Cui, Gino Pena, Bradley Ries, Haroula D. Baliaka, Ryan Ward, Sean Raffuse, Ann M. Dillner, Armistead G. Russell, John Seinfeld, Richard Flagan, Nga Lee Ng, Roya Bahreini, *University of California, Riverside*

In the Los Angeles (LA) Basin, ambient black carbon (BC) is heavily tied to the movement of goods via trucking. BC is a primary aerosol formed through the incomplete combustion of fuel and is a contributor to poor air quality, adverse health effects, reduced visibility and can directly and indirectly impact climate. Regulatory policies in the LA Basin have reduced BC emissions from transportation. To determine how the trajectory and patterns of BC have evolved in recent decades, this study evaluates equivalent BC (eBC) data from aethalometers (AE33) at two ASCENT and SCAQMD sites in the LA Basin as early as 2012, supplemented with elemental carbon (EC) data from the EPA dating back to 2010. We found that the decreasing trend in ambient EC concentrations since 2010 started reversing as early as 2016 across both LA and Rubidoux. Furthermore, analysis of weekly cycles revealed that as of 2023, while LA still experiences significantly higher eBC concentrations on weekdays compared to weekends, there is no longer a significant difference between weekend and weekday eBC concentrations in Rubidoux. Diurnal profiles of eBC indicate that this deviation stems from lack of a prominent morning weekend peak in eBC in LA, while the eBC concentrations remain elevated during the mornings at Rubidoux on weekends and weekdays. These findings suggest that ambient eBC concentrations in the LA Basin are not homogenous spatially or diurnally. Accounting for such changing dynamics will provide a more current characterization of eBC trends, enhance the accuracy of air quality predictions, and effectively inform policies to protect public health.

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9CA.26

Molecular-Level Comparison of Ambient Biomass-Burning Organic Aerosol and Phenolic Oxidation Products Formed in Aqueous and Humid Gas-Phase Environments. LINDSAY YEE, Antai Zhang, Qi Zhang, David Pando Gonzalez, Madeleine Sze In Ng, Nga Lee Ng, Michael Milazzo, Shan Gu, Robert Weber, Allen Goldstein, *University of California, Berkeley*

Biomass burning (BB) is a major source of atmospheric organic aerosol (OA), emitting chemically diverse compounds that undergo extensive transformation during atmospheric transport. Aqueous-phase processing in clouds, fog, and aerosol liquid water may contribute to BB secondary organic aerosol (aqBBSOA), yet molecular evidence linking laboratory oxidation products to ambient BB OA remains limited. Ambient observations have inferred aqueous processing from environmental conditions, BB-associated gas-phase compounds (e.g., phenols, furans, and sugars), and aerosol mass spectrometer (AMS) ion signals attributed to phenolic dimer formation. However, additional molecular signatures are needed to constrain the contribution of aqueous-phase processing to ambient BBOA.

Here, we characterize OA generated from laboratory oxidation of phenolic compounds commonly emitted by BB in bulk aqueous-phase experiments and gas-phase experiments under dry and elevated-relative-humidity conditions. Products were analyzed using comprehensive two-dimensional gas chromatography coupled with high-resolution time-of-flight mass spectrometry (GC×GC-HR-ToF-MS). We compare laboratory-generated product distributions and mass spectra with compounds previously observed in ambient BB-influenced measurements and catalogued in the UCB-GLOBES (University of California, Berkeley Goldstein Library of Biogenic and Environmental Spectra) mass spectral database.

Although laboratory-generated products can exhibit predicted carbon numbers and average carbon oxidation states similar to those of ambient BBOA, most mass spectra showed limited similarity to spectra of compounds previously observed in ambient BB-influenced particles. These results demonstrate that similar bulk OA properties do not necessarily indicate molecular-level chemical similarity and highlight the need for additional molecular constraints to identify the compounds and mechanisms contributing to ambient aqueous-phase BBOA.

9CA.27

Elemental Carbon (EC) Measurements in Addis Ababa: Comparing FTIR-EC with Optical Absorption Measurements in a Charcoal-Influenced Environment. AHMAD JALIL, Sina Hasheminassab, Kyan Shlipak, Tesfaye Mamo, Araya Asfaw, Hossein Kazemian, Ann M. Dillner, *University of Northern British Columbia*

Elemental carbon (EC) is a major component of $PM_{2.5}$ with significant health and climate impacts, yet its measurement remains sparse in low- and middle-income countries. The SPARTAN network, in support of the joint NASA–ASI (Agenzia Spaziale Italiana) Multi-Angle Imager for Aerosols (MAIA) satellite mission, provides filter-based aerosol composition measurements at globally distributed urban sites, including Addis Ababa, Ethiopia.

Within SPARTAN, EC is quantified from Fourier-Transform Infrared (FTIR) spectra using calibrations developed from collocated thermal-optical measurements of ambient samples collected at Interagency Monitoring of Protected Visual Environments (IMPROVE) network sites. We evaluate EC measurements in Addis Ababa, where widespread residential charcoal and biomass combustion produces carbonaceous aerosol that differs substantially from the largely rural and remote U.S. samples underlying these calibrations. FTIR-EC is compared with collocated optical absorption measurements from a Hybrid Integrating Plate & Sphere (HIPS) system and an MA350 aethalometer.

Cross-method comparisons show differences among the measurement methods at this unique, high-concentration site. Ongoing analyses are examining the spectral and compositional characteristics of Addis Ababa aerosol relative to the IMPROVE calibration samples, the influence of local combustion sources and seasonality on EC quantification, and approaches for developing calibrations that better represent charcoal-influenced environments.

We will present an assessment of EC measurement methods at this site and discuss implications for EC quantification across the SPARTAN network and in other regions dominated by local combustion sources.

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9CM.1

Characterization of Patient Transport Isolation Devices for High Consequence Infectious Diseases. JESSICA W. WARE, Joshua L. Santarpia, Ashley R. Ravnholdt, Elizabeth A. Klug, Vicki Herrera, Natasha R. Fields, *University of Nebraska Medical Center (UNMC)*

The safe transport of patients with high-consequence infectious diseases (HCIDs), such as Ebola and Marburg, requires Patient Transport Isolation Devices (PTIDs) that effectively manage pathogen sequestration and aerosol containment. While HCIDs are often linked to direct contact, aerosols generated during patient loading and long-distance transport pose a major risk to care teams. This study evaluated the Airboss defense group ISO-POD (Canada), the EpiShuttle (Norway), the ISOVAC (United States), a wheelchair isolator (Japan), and a Portable Biocontainment Unit (PBCU). We characterized these devices by assessing air exchange rates (ACH), interior environmental conditions, and containment effectiveness. Effectiveness was determined using DNA-tagged salt particles and aerosol clearance rates, using ASHRAE 241 standards as a benchmark for the PBCU to ensure effective air flow and containment during occupancy.

Our findings revealed that all of these devices contained the test aerosol at similar or higher levels than an N95, with most at HEPA containment levels. Only one device showed external contamination. However, environmental monitoring with healthy subjects showed elevated CO2 in all single-person units and the presence of VOCs and HCHO in the EpiShuttle only. Additionally, half of the devices exhibited ACH levels slightly lower than manufacturer specifications. PBCU testing with ASHRAE 241 techniques with air flow blowers calibrated at 11.46 m/s (top) and 13.6 m/s (bottom) showed acceptable ACHs with successful unit clearing for biocontainment operations. Containment effectiveness with DNA-tagged aerosols reveals effective containment with no transfer of aerosols from the patient's room to the donning/doffing areas. These results demonstrate the function and limitations of both PTIDs and PBCU for the transport and isolation of HCID patients.

9CM.2

Far-UVC for Airborne Pathogen Mitigation. Steve Martin, Brian Renda, KELSEY QUINN, Richard Williamson, Darryl Angel, Jacob Swett, *Blueprint Biosecurity*

Airborne pathogen transmission remains a critical public health challenge, as underscored by the COVID-19 pandemic. While existing engineering controls, including ventilation, filtration, and upper-room UV can reduce infectious bioaerosol concentrations, they face limitations among energy efficiency, noise, and achievable clean air delivery rates. In contrast, far-UVC radiation (200-235 nm) may serve as a safe and effective whole-room transmission suppression treatment in occupied spaces.

Far-UVC is primarily generated by krypton chloride excimer lamps at 222nm. This wavelength offers a potentially transformative approach to air cleaning, being strongly absorbed by proteins in the outermost layers of human skin and eyes, while remaining capable of inactivating a wide range of airborne pathogens, enabling whole-room treatment. Blueprint Biosecurity conducted a comprehensive multidisciplinary evaluation, incorporating literature review, modeling analysis, and consultations with subject matter experts to evaluate far-UVC as an effective treatment technology. The resulting report extensively summarizes the state of efficacy, safety, air quality, standards, and additional factors relevant to far-UVC deployment. We further identify urgent research priorities for widespread far-UVC adoption, including establishing far-UVC design installations for effective airborne transmission suppression, identifying biological effects associated with far-UVC exposure, understanding unintended air quality impacts and mitigation options, and obtaining real-world effectiveness data.

Despite significant progress among far-UVC research, uncertainties across efficacy, safety, air quality, emitter technology, and standards must be resolved before widespread deployment is possible. Blueprint Biosecurity is actively coordinating and funding research to address these open questions. Our current research program includes analysis of pathogen susceptibility within human-generated bioaerosols and efficacy against hard-to-inactivate microorganisms, resolving the central question of how much far-UVC is needed while addressing the principal safety concerns around ocular effects and indoor air chemistry. Additionally, we are facilitating the path toward a definitive cluster-randomized trial, providing a comprehensive assessment to evaluate and enable the large-scale deployment of far-UVC.

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9CM.3

A CFD-Based Reduced Order Modeling Framework for Rapid and Reliable Digital Twin Development to Evaluate Indoor Air Quality and Thermal Comfort in a Classroom. HANG YI, Yu Feng, *Oklahoma State University*

Indoor air quality (IAQ) and thermal comfort in educational settings critically influence student health, well-being, focus, and cognitive performance. However, conventional heating, ventilation, and air conditioning (HVAC) systems are often not customized or optimized for the specific geometry, occupancy pattern, ventilation layout, and thermal conditions of individual classrooms. This limitation is partly due to the lack of detailed spatiotemporal information on indoor environmental fields, including gas concentrations, temperature, pressure, airflow patterns, and humidity. While physical sensors provide point-wise measurements, they cannot practically capture full three-dimensional distributions throughout an occupied classroom, especially within students' breathing zones. Computational fluid dynamics (CFD) can provide these detailed insights, but its high computational cost limits real-time prediction and optimization. To address this need, this study develops a rapid CFD-guided reduced order model (ROM)-based digital twin framework to evaluate air quality and occupant thermal comfort in a virtual classroom measuring 9 m x 8 m x 4 m. The classroom includes 16 students, furniture, four ventilation inlets/outlets, two windows, and one door. High-fidelity CFD simulations were conducted to predict temperature, O_2, CO_2, and relative humidity within each student's breathing zone, defined as a 0.25 m-radius sphere around the mouth. Ventilation conditions were varied by changing inlet velocity from 0.5 to 2.5 m/s and inlet temperature from 293.15 to 298.15 K. In this preliminary study, eight CFD datasets generated using an optimal space-filling design were used to train a ROM with 10 modes and 68 output indicators. The ROM accurately learned the CFD datasets, with relative L_2 errors of 1.0E-4, 1.1E-9, 9.0E-9, and 3.4E-9 for temperature, O_2, CO_2, and RH, respectively. Verification testing further demonstrated that the ROM was robust in predicting O_2 and T, with RL2Es of 0.024 and 3.8E-4. However, due to the limited number of training samples, prediction errors remained relatively high for CO_2 and RH, with RL2Es of 0.4 and 0.1. Future work will expand the training dataset to 32 or more learning points to improve the accuracy, robustness, and generalizability of the CFD-ROM digital twin framework. The long-term goal is to develop the ROM-based digital twin into a rapid, reliable, and optimization-ready tool for classroom-specific intelligent ventilation control. In its final version, the digital twin will enable rapid prediction of spatially resolved air-quality and thermal-comfort indicators under different HVAC operating conditions. It will enable customized HVAC optimization strategies that improve breathing zone air quality, maintain thermal comfort, and substantially reduce computational cost relative to repeated high-fidelity CFD simulations.

9CM.4

Assessment of Indoor Mold Burden in a Residential Setting Using a Multilayered Strategy: A Case Study. JUDITH ARTHUR, Sripriya Nannu Shankar, Perminder Kaur, Jagjit Yadav, Aaron Grant, *University of Cincinnati*

Indoor mold exposure contributes to respiratory irritation, allergic responses, and asthma exacerbation, particularly among susceptible individuals. This study focuses on the field assessment of a multi-layered sampling/control strategy aimed at minimizing exposure risks to fungal spores. In February 2026, a Cincinnati resident experienced respiratory issues, raising concerns about indoor air quality. An initial third-party assessment using Spore trap method found elevated mold levels in the bedroom (13,280 spores/m3) and bathroom (25,480 spores/m3). In both rooms, Aspergillus/Penicillium spores were predominant (Bedroom: 12,920 spores/m3; Bathroom: 25,240 spores/m3), while basidiospores, Epicococcum, Smuts/Periconia/Myxomycetes, and hyphal fragments contributed to the remainder. While the resident fixed plumbing leaks, changed HVAC filters, and used a mold-control wipe, respiratory symptoms persisted, prompting a temporary relocation while the bathroom underwent a complete renovation.

In April 2026, our team sought to quantify mold concentrations and evaluate the effectiveness of a muti-layered 24 hour control strategy in the bathroom (EPA recommended mold control agent, air purifier, UV-C lamps, and natural ventilation). The GRIMM spectrometer, Instascope, and a spore trap were used to record the total aerosol concentration, total fungal/pollen concentrations, and a comprehensive panel of mold diversity, respectively. Data from the Instascope revealed no significant difference in the total mold/pollen concentrations in the bedroom on both sampling days, while there was a 73% reduction in the bathroom after implementing the control strategy. Although the mass concentrations were generally lower in both rooms on both days of sampling (<5 µg/m3), a microscopic analysis revealed the presence of diverse fungal spores. On Day 1, the predominant ones were Aspergillus/Penicillium, Cladosporium spores, and Basidiospores. Curvularia, Ganoderma, Nigrospora, and Ulocladium were only present in the bedroom, as compared to the bathroom where Pithomyces and Torula were unique. On Day 2, after 24 h of the control strategy, the total spores/m3 declined by ~84% in the bedroom and ~55% in the bathroom with reduction in Aspergillus/Penicillium spores: ~58% in the bathroom and ~94% in the bedroom post-treatment. Compared to the levels in February, the total spore concentrations had declined by 85-88% post interventions. Cumulatively, our study demonstrates the need for a multi-layered control strategy in minimizing exposure risks to bioaerosols.

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9CM.5

Optical-Spectrometry Characterization of Miniature Cyclones as Inertial Separators in a Condensed-Aerosol Recovery System. Rafael Venancio Durand, Francesco Ghione Roasio, Roberto Guido, Stefano Zago, Emanuele Norata, PAOLO TRONVILLE, *Politecnico di Torino*

Inertial separators play a crucial role in condensed-aerosol recovery systems designed for capturing condensed volatile organic compounds. High-efficiency cyclone designs are particularly suitable for removing condensed particles from wood pyrolysis exhaust streams, where efficient separation is essential for both environmental compliance and the recovery of valuable byproducts.

Two small-scale reverse-flow cyclones (Stairmand-HE, D = 38 mm; Swift-HE, D = 40 mm) were manufactured by selective laser sintering and tested in a dedicated test rig. HEPA-filtered air was mixed with a polydisperse DEHS aerosol generated by a Laskin nozzle. Upstream and downstream size distributions were measured sequentially with two optical particle spectrometers. Each cyclone was tested at flow rates from 3 to 10 $m^3\ h^{-1}$.

Fractional efficiency curves shifted toward smaller diameters as the flow rate increased. From LAS 3340A data, the estimated cut size (d50) decreased from ~2.20 µm at 3 $m^3\ h^{-1}$ to 0.67 µm (Stairmand-HE) and 0.56 µm (Swift-HE) at 10 $m^3\ h^{-1}$. At the design flow rate (8 $m^3\ h^{-1}$), Swift-HE outperformed Stairmand-HE in the 0.7–1.6 µm range (η = 66% vs 54% at 0.7–1.0 µm; 87% vs 74% at 1.0–1.3 µm). Pressure drop increased approximately quadratically with flow (0.22–2.75 kPa across the tested range), with Swift-HE consistently higher.

Comparison with the Iozia–Leith semi-empirical model reproduced the overall trend, matching Stairmand-HE reasonably well at moderate flows but systematically underpredicting Swift-HE as flow increased. These measurements provide a modern benchmark dataset for validating cyclone efficiency correlations and CFD simulations of standard high-efficiency geometries, and for quantifying additive-manufacturing tolerance effects on performance.

This study was carried out within the MICS (Made in Italy – Circular and Sustainable) Extended Partnership and received funding from Next-GenerationEU (Italian PNRR – M4C2, Invest 1.3, D.D.1551.11-10-2022, PE00000004).

9CM.7

Energy Recovery Ventilators: Are They a Source of Nanoparticulate Aerosol Indoors? ONYINYE A. EZEIFEKA, Yevgen Nazarenko, *University of Cincinnati*

Energy recovery ventilators (ERVs) are increasingly used in residential and commercial buildings to improve indoor air quality and energy efficiency. However, their potential to be a source of aerosol emissions indoors has not been assessed. This study investigated whether ERVs generate measurable particle emissions across operationally relevant conditions and whether emissions vary by device design and power setting. Five commercially available ERV units, assigned randomized identifiers (ERV1-ERV5) to prevent selection bias, were tested individually at low, medium, and high-power settings inside a Thermo Scientific Class II Type A2 Biological Safety Cabinet to ensure a particle-free measurement environment. Each condition was replicated three times. Aerosol number concentrations were measured simultaneously using a TSI Fast Mobility Particle Sizer (FMPS, Model 3091) and a TSI Optical Particle Sizer (OPS, Model 3330), characterizing particles across the 5.6-560 nm and 0.3-10 µm size ranges, respectively. A two-way ANOVA with Tukey-Kramer HSD post hoc testing evaluated the effects of ERV model, power level, and their interaction on particle concentrations. OPS results demonstrated that both ERV model and power level influenced coarse particle emissions, with a significant interaction effect ($p < 0.0001$ for all factors). ERV1 at medium power produced the highest particle concentrations, substantially exceeding all other configurations. ERV5 exhibited the lowest emissions across all power settings. FMPS data identified ERV5 at low power and ERV2 at medium power as outlying configurations with elevated nanoparticle concentrations relative to all other conditions. These findings demonstrate that ERV design and operating conditions dramatically influence the number of aerosol particles they emit into indoor air. The discovery has implications for indoor aerosol pollution management, occupant exposure assessment and ventilation system selection in indoor environments where minimal particulate air pollution is desired.

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9CM.8

Evaluating a Low-Cost Heated-Inlet PM_{10} Sensor Across Diverse Global Collocation Sites. JACK KODROS, David Lu, *Clarity Movement Co.*

Accurate PM_{10} measurement remains a major challenge in low-cost air sensing. While affordable sensors have expanded access to $PM_{2.5}$ data, most struggle to detect coarse-mode particles that dominate dust emissions.

This study presents a new low-cost PM_{10} sensor designed for near-reference performance. The system combines three innovations: an improved optical particle counter (OPC) with enhanced coarse-mode sensitivity, a resistive heated inlet that suppresses humidity interference while remaining compatible with solar-powered deployments, and algorithmic corrections that adapt to local aerosol environments.

These innovations were evaluated through an ongoing collocation campaign at six sites across four countries, spanning arid desert, coastal, agricultural, and urban environments. Sixteen modules have been assessed against reference instruments over several months, with data collection and site expansion ongoing.

Field testing of the new OPC demonstrates a strong correlation (R^2: 0.7-0.8) in the coarse-mode size fraction relative to the reference instrument, substantially improving correlation relative to the previous-generation sensor (R^2: 0.1 - 0.3). A controlled heater experiment at a fog-prone California site showed that the heated inlet reduced fog-artifact frequency by 2-5x and cut positive bias by 10-14 $\mu g/m^3$ at sub-fog humidity levels (RH 90-100%). On the algorithmic side, at high-dust arid sites, batch-level calibration alone achieved hourly R^2 of 0.81-0.92 with RMSE of 22-25 $\mu g/m^3$. Device-specific calibration approaches, including mixed-effects modeling and site-specific regression, further improved precision and accuracy (RMSE reduced by 20-50%) at most sites. Ongoing work is exploring additional calibration covariates to reduce residual bias.

This presentation will share the latest cross-site findings, examine performance trade-offs across aerosol regimes, and discuss implications for global deployment in dust, wildfire, and construction monitoring contexts. The results inform best practices for calibration, siting, and data interpretation when deploying low-cost PM_{10} networks at scale.

9CM.9

Leaf Surfaces as Aerosol Sinks: Dry Deposition Velocities for Common Urban Tree Species in Los Angeles. JACKSON RYAN, Thaomy Vo, William Berelson, Devan Roper, Celia Faiola, *University of California, Irvine*

Urban aerosols are a significant concern for public health in megacities. Urban trees have been proposed as a possible mechanism for air pollution remediation in cities such as Los Angeles. While previous work has identified and established that tree leaves can provide a suitable and attractive surface for particle dry deposition. There is a large uncertainty in the understanding of particle deposition velocity to leaf surfaces. This work addresses that uncertainty by measuring the deposition of different particle types and sizes to diverse leaf morphologies. Researchers carried out this work using an atmospheric chamber, a converted greenhouse, at the University of Southern California. Polydisperse aerosol distributions of ammonium sulfate and sucrose were atomized onto the leaf surfaces of Pinus canareinsis and Lophostemon confertus tree leaves, both prevalent urban trees in downtown Los Angeles, and into the empty greenhouse. The aerosol size distribution was evaluated with and without the presence of plants while parameters such as CO2, temperature, relative humidity, and ozone were tracked. Stomatal resistance and mesophyllic resistance were isolated through the tuning of experimental parameters and evaluated. Pinus canareinsis leaves showed a faster deposition velocity for ammonium sulfate aerosols than Lophostemon confertus leaves. While Lophostemon confertus exhibited less responsive stomata under changing light conditions. The parametrization for the dry deposition to the leaf surface can provide for the development of new modeling schemes that may inform policy decisions at the city and regional level.

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9CM.10

Effects of Environmental Factors on Far-UVC Inactivation of Virus-Laden Droplets. Xuefang Jing, JIN PAN, *The University of Iowa*

Far-ultraviolet C light (far-UVC, 200–235 nm) has emerged as a promising approach for mitigating transmission of respiratory infectious diseases. However, the efficacy of far-UVC against virus-laden aerosols in real-world settings remains insufficiently characterized, largely due to varied environmental conditions and interactions with other respiratory proteins. We discovered that relative humidity (RH) impacted the inactivation efficacy of far-UVC against an enveloped bacteriophage, phi6, with the inactivation rate constants of 0.19, 0.34, and 0.15 cm^2/mJ at 20%, 50%, and 80% RH, respectively, in 1-µL phosphate-buffered saline droplets on polyester film. However, RH showed no effects on a non-enveloped bacteriophage, MS2, with the inactivation rate constants of 0.09, 0.09, 0.10 cm^2/mJ at 20%, 50%, and 80% RH, respectively. The porosity of surface materials also plays a vital role in far-UVC inactivation efficacy. MS2 did not decay on polyester fabric at a fluence up to 33 mJ/cm^2, whereas it exhibited a 3 log_{10} reduction on polyester film at the same fluence. However, we were unable to recover phi6 from polyester fabric, indicating that phi6 may strongly adhere to the porous surface. These data suggest that environmental conditions, such as RH and surface porosity, can influence the efficacy of far-UVC inactivation against different viruses. In future work, we will elucidate mechanisms of far-UVC inactivation against viruses in aerosols under varying environmental conditions.

9CM.11

Impact of Air Purifiers on Particulate Matter and the Household Dust-Associated Microbiome: A Pilot Study. CLARA EICHLER, Megan Lott, Sherlynette Pérez Castro, Em Nortmann, David Singleton, Thomas Clerkin, Zoe Schubert, Rylee Beaver, Sarah Haines, Claudia Gunsch, Rachel Noble, Glenn Morrison, Barbara Turpin, *University of North Carolina at Chapel Hill*

Air purification through filtration in homes can benefit the occupants' health by reducing allergen, particulate matter (PM), and pathogen concentrations in indoor air. However, the impact of air filtration on the household dust-associated microbiome has received little attention to date. Here, we evaluate whether air purifiers (APs) produce measurable changes in indoor microbial abundance associated with dust relative to a no-AP condition. As part of the broader method development, we conducted a two-week pilot study in an unoccupied, controlled test house. A composite household dust was prepared, spiked with a microbial tracer, and used to inoculate a defined floor area (7.6 m^2, hardwood) in a second-floor "intervention room". During the first week (no AP), sampling took place before (baseline) and shortly after dust inoculation (T1), and again after five days (TF). Sampling included agar and polytetrafluoroethylene (PTFE) deposition samplers distributed throughout the house, aerosol sampling in the intervention room and outside the house, and filter swabs. The dust was resuspended regularly over the five-day experimental period by walking. Airborne PM concentrations were measured in multiple rooms using PurpleAir sensors. The protocol was repeated during the second week, during which an AP was operated continuously in the intervention room. As expected, PM concentrations in the intervention room were lower during AP operation (69% reduction of $PM_{2.5}$), while they remained comparable in other rooms. Dust inoculation generated a dispersal pulse, with bacterial and fungal markers increasing 3-11 times from baseline to T1. These signals remained elevated through TF (13-20 times above baseline) and were similar with and without AP operation, indicating no measurable reduction in dust-associated microbial abundance. Overall, house- and outside-originating microbial signatures dominated. This pilot study informs further method development and experiments aimed at understanding the impact of APs on the microbiome of the built environment.

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9CM.12

Pressure Drop in 2D Nanofiber Filters: Dimensionless Design for Size-Independent Domains. TAEHYUN CHOI, Jae Hee Jung, Ki Joon Heo, *Chonnam National University*

Nanofiber air filters have attracted considerable attention because, when the fiber diameter approaches the mean free path of air molecules, slip flow occurs at the fiber surface, enabling the simultaneous realization of low pressure drop and high filtration efficiency. However, the pressure drop performance of nanofiber filters is strongly influenced by structural parameters such as fiber arrangement, packing density, and filter thickness. Even when material properties are identical, variations in structural configuration can significantly alter flow resistance.

Two-dimensional computational fluid dynamics (CFD) simulations, which simplify the filter structure into a cross-sectional model, are widely employed to predict the pressure drop of nanofiber filters. Nevertheless, due to the inherent randomness of fiber distribution, the simulation results are highly sensitive to the size of the computational domain. Previous studies have typically relied on empirical domain selection or increasing the number of fibers to achieve stable predictions. However, systematic and generalized design criteria for constructing size-independent domains that account for fiber randomness remain insufficient. As a result, ensuring statistically reliable predictions often requires excessive computational cost.

In this study, we propose a dimensionless design rule for constructing size-independent domains in two-dimensional nanofiber filter models, using the fiber diameter as a reference parameter. Comprehensive computational analyses are conducted to evaluate the effects of domain thickness, packing density, and fiber number on the predicted pressure drop.

9CM.13

Real-Time Detection of Narcotics and Explosives Using Single-Particle Mass Spectrometry. Johannes Passig, HASEEB HAKKIM, Aleksandrs Kalamasnikovs, Petra Hehet, Guanzhong Wang, Heinrich Ruser, Michael Pütz, Martin Seipenbusch, Simone Vinati, Karsten Wegner, Thorsten Streibel, Robert Irsig, Sven Ehlert, Andreas Walte, Ralf Zimmermann, *University of Rostock*

Beyond conventional air pollution, hazardous dusts pose substantial risks to human health and public safety, for example through accidental releases of toxic substances or during the illegal transport and handling of drugs. The ongoing opioid crisis in the United States has highlighted the lack of technologies capable of detecting hazardous particulate matter in real time. To address this challenge, we developed a comprehensive detection approach combining (i) pulsed particle resuspension, (ii) high-flow aerosol sampling and enrichment, (iii) resonant ionization single-particle mass spectrometry (SPMS), and (iv) real-time pattern recognition using machine learning.

The core technology of this approach is SPMS, which enables the chemical characterization of individual particles within complex aerosol mixtures. By resonantly exciting aromatic molecular structures, the system is specifically tailored toward the detection of particulate residues from drugs and explosives. We present representative single-particle mass spectra of various drugs and demonstrate how interferences from chemically complex background aerosols can be effectively resolved.

To enable direct surface screening, we developed a dedicated sampling interface for the modified SPMS, incorporating pulsed gas-driven particle resuspension and aerosol enrichment for efficient collection from contaminated surfaces. Field measurements conducted at the DHL Hub Leipzig demonstrated the capability to identify packages containing illicit drugs in real time. In addition, experiments performed in a former illegal drug laboratory showed successful online detection of drug and tablet residues from contaminated floors and surfaces.

To facilitate rapid hazard assessment and online screening of dangerous particulate matter, we further developed a real-time data analysis framework including preprocessing, particle screening, clustering, and machine-learning-based classification. Supervised learning approaches for particle identification and classification were evaluated and shown to outperform traditional unsupervised methods such as ART-2a clustering in both speed and classification accuracy, thereby enabling near real-time analysis and rapid emergency response.

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9CM.14

Evaluating Upper-Room UVGI in Shared Patient Wards Using Eulerian-Multiphase CFD Model. JONGIL BANG, Donghyun Rim, *Sejong University*

Shared healthcare environments, particularly multi-patient wards, require advanced infection control technologies to mitigate the heightened risk of airborne disease transmission. This study investigates the performance of upper-room ultraviolet germicidal irradiation (UR-UVGI) combined with mechanical ventilation for airborne infection control using an Eulerian-multiphase CFD model. A four-bed ward was modeled based on experimental data from a prior study. To evaluate disinfection efficacy, bioaerosols were released for 20 minutes from a specific bed, and the subsequent concentration decay was monitored at the other three beds. Simulation cases were categorized by air changes per hour (2.5 h-1 and 6.9 h-1) and the number of operational UVGI units (0, 1, and 2). Performance was quantified as the equivalent air exchange rate (eACH) derived from the decay curves at each bed. Under the 2.5 h-1 condition, the average eACH estimates were 4.12 h-1 (EXP: 3.67) for UV OFF, 5.1 h-1 (EXP: 5.41) for one UV unit, and 5.82 h-1 (EXP: 5.45) for two units. For the 6.9 h-1 condition, the eACH values were 5.93 h-1 (EXP: 6.24) for UV OFF, 7.36 h-1 (EXP: 8.42) for one unit, and 7.82 h-1 (EXP: 9.0) for two units. While the CFD results generally aligned with experimental trends, with observed discrepancies remaining below 20%, larger deviations were observed at 6.9 h-1 condition. Notably, the CFD analysis revealed significant spatial heterogeneity in eACH value across different beds, likely due to airflow pattern variations between the source and adjacent beds. These findings suggest that strategic placement of UVGI units, considering airflow patterns rather than mere ventilation increases, is essential for infection control in multi-patient wards.

9CM.15

Efficiency of Emissions Capture Systems at Removing Light and Heavy Hazardous Air Pollutants for Maritime Emissions Sources. JOULE PARKER, Kyah Gracia, David R. Cocker, Thomas Eckel, *University of California, Riverside*

Maritime shipping is a major contributor to the emissions inventory, and the localization of maritime sources in ports significantly impacts air quality in port cities. Across various engine tiers on ocean-going vessels (OGVs), barge-mounted emission control systems (ECSs) are used at berth to regulate macro emissions like nitrogen oxides (NOx), particulate matter (PM), and volatile organic compounds (VOCs). ECSs aim to mitigate these pollutants by capturing and controlling emissions before they are released to the atmosphere. This study expands on the impacts of ECS, measuring air toxics when maritime auxiliary engines are in use at berth during cargo operations.

A full spectrum of emissions was measured before and after an ECS, including measurements of light and heavy hazardous air pollutants (LHAPs and HHAPs, respectively). A comprehensive set of measurements were conducted for both gas and particle phase emissions.

This study provides a foundational framework for the evaluation of maritime emissions of toxics at berth. This data allows for the evaluation of ECS performance beyond typically relevant criteria pollutants through the inclusion of LHAP and HHAP measurements. The increasing implementation of barge-mounted ECS on cargo ships at berth allows for a more comprehensive emissions profile, in turn supporting future efforts for creating emissions inventories, assessing exposure, and evaluating regulations of maritime air pollution mitigation strategies.

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9CM.16

Influence of Lighting Conditions on Aerosol Formation from Bleach and Cleaning Product Vapors. ESTHER OZURUOHA, Sofie Schwink, Ethan Richter, Marina Vance, *University of Colorado Boulder*

People spend most of their time indoors where common cleaning practices can generate airborne particles. We investigate SOA formation from reactions between chlorine bleach and volatile organic compounds (VOCs) emitted by an all-purpose cleaning liquid under varied lighting conditions typical of indoor environments. Chamber experiments are conducted in a 0.55 m^3 Teflon chamber. We establish a chlorine-rich atmosphere by flowing bleach vapor overnight, then introduce cleaning-product vapors while varying illumination, including GUV 254 nm, GUV 222 nm, fluorescent, incandescent, LED, natural light, and dark conditions. Particle size distributions are measured with a Scanning Mobility Particle Sizer (SMPS), and an Aerosol Particle Mass analyzer (APM) provides size-resolved mass to derive effective density and convert numbers to mass concentrations. Early results indicate lighting conditions significantly impact SOA formation potential, with light in the ultraviolet range producing the highest particle mass and discernible shifts in size modes relative to dark experiments. These findings underscore the role of indoor photochemistry in the amount of SOA produced during routine cleaning and point to practical exposure-reduction strategies, such as product sequencing, ventilation timing, and lower-emission formulations.

9CM.17

Particle Dendrite Formation on a Single Fibre in the Slip-Flow Regime: Pressure Drop Modelling in the Diffusion-Dominant Range. TAEHYUN CHOI, Ki Joon Heo, Jae Hee Jung, *Chonnam National University*

When the fiber diameter approaches the mean free path of gas molecules (64 nm at STP), the continuum assumption fails, and rarefaction effects become dominant. The resulting slip flow at the fiber surface, where the gas retains a finite velocity, is a key mechanism enabling the low pressure drop characteristic of nanofiber filters. This slip velocity significantly alters the localized flow field and particle transport, leading to capture mechanisms distinct from those found in the conventional micro-scale continuum regime. Despite its importance, conventional models for particle deposition and pressure drop evolution remain largely confined to the continuum regime, failing to accurately predict the complex particle morphology (dendrites) in the nano-scale slip flow regime.

To bridge this gap, this study analyzes the microscopic flow structures around fibers by reflecting these nano-scale aerodynamic characteristics. Based on this flow analysis, a three-dimensional continuous particle attachment algorithm was developed to simulate the progressive accumulation of particles. Using this framework, the particle collection behaviors on single nanofibers with diameters of 100, 300, and 900 nm were investigated and compared under both slip and no-slip conditions in the diffusion-dominant regime.

The simulations reveal that slip flow promotes a uniform deposition profile on the single fiber, delaying the transition from depth to surface filtration and mitigating rapid pressure drop escalation. Furthermore, the interplay between slip effects and dendrite morphology was evaluated under various fiber-to-particle diameter ratios. In particular, the transition of dominant factors dictating the pressure drop was elucidated across structural scales. These findings demonstrate that non-continuum effects critically govern dendrite morphology and filtration dynamics, providing essential insights for optimizing next-generation nanofiber filters.

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9CM.18

Dust Resuspension of the Collected Particles via Electrodynamic Screen. Kisoo Jeon, Chaeyeon Jo, Kee-Jung Hong, Gunhee Lee, BANGWOO HAN, *Korea Institute of Machinery & Materials*

This study investigated the feasibility of applying an Electrodynamic Screen (EDS) to remove particulate matter deposited on the collection plates of an Electrostatic Precipitator (ESP). The EDS was proposed as an alternative to conventional cleaning methods, such as mechanical rapping and water washing, which can cause particle re-entrainment, plate damage, and wastewater generation. A laboratory-scale EDS was fabricated, and the effects of operating parameters, including electric field strength, driving frequency, waveform, phase difference, electrode spacing, electrode width, and relative humidity, were systematically evaluated. The results showed that the cleaning performance strongly depended on the operating conditions. The highest cleaning efficiency was achieved at an electric field strength of 2 kV/mm, a driving frequency of 1 Hz, a square waveform, a 180° phase difference, an electrode spacing of 7 mm, and an electrode width of 0.5 mm. Under these conditions, the overall particle removal efficiency reached approximately 65%, while the cleaning efficiency within the active cleaning region was about 94%. The study also revealed that increasing relative humidity significantly reduced the cleaning efficiency, indicating that moisture increased the adhesion of deposited particles and hindered their electrostatic transport. In addition, excessively high driving frequencies decreased particle removal because the particles could not respond sufficiently to the rapidly changing electric field. These results demonstrate that EDS has the potential to serve as an effective dry-cleaning technology for ESP collection plates when operated under optimized conditions. The findings provide useful design guidelines for improving EDS performance and suggest that further validation under practical industrial operating conditions is necessary for large-scale implementation.

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9CM.19

Effect of Glycol Vapors Exposure on Filtration Performance of Air Filtration Media. BRIGHT AMPONSEM, Sudheer Salana, Pulanthitan Pulanthitan, Ian Chen, Mohammad Washeem, Chang-Yu Wu, *University of Miami*

While Triethylene Glycol (TEG), Propylene Glycol (PG), and Dipropylene Glycol (DPG) glycol vapors have been demonstrated for their antimicrobial activity against airborne microbes, their effects on filtration media remain insufficiently characterized. This study aims to assess the effect of glycol vapor exposure on the particle filtration performance of P100, N95, MERV-13, MERV-13A, MERV-8, and HEPA filter media at saturation ratios ($S = 1$, $S < 1$, and $S > 1$) and relative humidities of 30%, 50%, and 70%. Filter samples were evaluated before (control) and after glycol vapor exposure. Filtration efficiency, pressure drop, and normalized surface potential were monitored to assess potential changes in airflow resistance and electrostatic charge characteristics. Our initial results from TEG exposure on P100, N95, and HEPA filters, using Polystyrene Latex aerosol to determine collection efficiency at hourly intervals over an 8 h period (short-term exposure), showed different response characteristics among the filter types. Two-way ANOVA showed negligible effects on P100 and HEPA filter performance ($p > 0.05$), whereas N95 respirators exhibited significant reductions in filtration efficiency ($p < 0.05$). Surface potential declined over time for both P100 and N95 filters under both glycol-exposed and control conditions. However, pressure drop measurements remained largely unchanged for both glycol-exposed and control samples for P100, HEPA, and N95 filters. Overall, our initial findings demonstrate that glycol vapor-fiber interactions alter particle capture performance by influencing the relative contributions of mechanical and electrostatic mechanisms. These findings can help establish operational guidelines to optimize filtration performance while maintaining the biosecurity benefits of glycol vapor deployment.

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9CM.20

Effects of Elevated Concentrations of Ammonia and Hydrogen Sulfide on Non-Thermal Plasma Inactivation of Airborne Viruses. EMILY HONG, Zhenyu Ma, Herek L. Clack, *University of Michigan*

Airborne viruses are a health concern for both human and livestock health. There has been an increase in outbreaks of avian influenza and other airborne transmissible diseases affecting livestock. To combat the increase in outbreaks, technology suited for inactivating airborne viruses in environmental conditions typical in livestock raising and farming is needed. This study uses non-thermal plasma (NTP) to inactivate airborne viruses in ambient air compositions similar to poultry farm conditions. Ambient air in poultry farms contains high concentrations of ammonia (NH3) and hydrogen sulfide (H2S). Poultry farms have varying concentrations of NH3 and H2S that exceed 5 ppm [1,2]. Our previous work has established the effects of 1 and 5 ppm of NH3 and H2S on NTP inactivation of airborne viruses [3]. This work examines the effects on NTP inactivation of airborne viruses at elevated concentrations of NH3 and H2S (above 10 ppm) using MS2, a bacteriophage considered to act as a conservative surrogate for pathogenic airborne viruses.

Gas cylinders were used for NH3 trace gas addition [3]. But for more economical and sustainable purposes, we switched to liquid vapor dosing for the elevated concentrations of NH3. Stable concentrations of NH3 in flowing air were achieved by exposing compressed air to NH3 vapors evaporating from 25 mL of liquid household ammonium hydroxide (1-3%) in an open beaker. The open beaker is placed inside an enclosure with a fitting to transport NH3 into the NTP setup. Trials conducted using this method have achieved an NH3 concentration level over 10 ppm downstream and have yielded inactivation results comparable to previous results using a gas cylinder. Using the liquid vapor dosing method with 25% ammonium hydroxide will produce higher concentrations of NH3 comparable to poultry farm conditions.

Previous results for 1 and 5 ppm of NH3 and H2S showed statistically significant log inactivation differences with and without trace gases. But between the 1 and 5 ppm of trace gases there was no statistical difference in log inactivation. Our preliminary results are showing 10 ppm of NH3 log inactivation is not statistically different from 1 and 5 ppm. It is expected that higher concentrations of NH3 and H2S will not result in statistically significant differences in log inactivation. A gas cylinder for H2S will be used for the concentrations above 10 ppm.

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9CM.21

A Generalizable Size-Resolved Framework for Predicting How HVAC Filter Aging Modulates Excess Lifetime Cancer Risk from Outdoor Ultrafine Particles. CHUNXU HUANG, Brandon E. Boor, *Purdue University*

Inhalation exposure to outdoor aerosol occurs primarily indoors, and in mechanically ventilated buildings HVAC filters are the primary interface between outdoor and indoor atmospheric environments. Particle size governs the efficiency with which HVAC filters remove outdoor aerosol particles, and where inhaled particles deposit in the respiratory tract. These dependencies influence the deposited surface area dose occupants receive, and the excess lifetime cancer risk (ELCR) scales with that dose weighted by the toxic potency of the aerosol mixture. We present a generalizable framework for predicting the fraction of ELCR from outdoor ultrafine particles (UFPs, ≤100 nm) that an HVAC filter removes. The framework comprises size-resolved terms: an outdoor particle size distribution (PSD), the in situ efficiency of real HVAC filters, particle losses in ductwork and on indoor surfaces, respiratory deposition fractions, and a toxicity slope factor. Terms are modular: published source-resolved PSDs and slope factors for wildfire, traffic, or industrial regimes substitute where in situ data are unavailable. The efficiency term comes from a custom-built, full-scale rig that aged HVAC filters under continuous outdoor aerosol exposure, giving weekly size-resolved efficiencies (10–100 nm) over two years for MERV8 pre-filters paired with MERV8, MERV13 electret, or MERV14 final-filters. Upstream, the outdoor aerosol corresponded to an ELCR of 10^{-4} to 10^{-3}, above the U.S. EPA limit. The MERV14 final-filter reduced ELCR by about one order of magnitude over two years, whereas the MERV13 electret returned to near-upstream risk within 30 weeks as its charge decayed; the dual MERV8 gave negligible reduction. Filter efficacy therefore depends on the aging trajectory of the media and the position of the source PSD relative to the most penetrating particle size, not the nominal rating. The framework thus quantifies how HVAC filters modulate ELCR from indoor exposure to outdoor aerosol, making filter selection and replacement a health-based decision.

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9CM.22

Multiphysics Effects of Moisture on Electrostatically Charged Aerosol Filters. Amit Kumar, HOOMAN V. TAFRESHI, Behnam Pourdeyhimi, *North Carolina State University*

Electret filters use electrostatically charged fibers to achieve high aerosol capture efficiency without added pressure drop, making them essential to respiratory masks and HVAC filters. Unfortunately, electrostatically charged fibers can lose their effectiveness when they are exposed to airborne contaminants such as oil mist, humidity, and dust particles, and the underlying physics of this performance degradation has not yet been formulated. In this concern, we have developed a novel computational model that couples the Lagrangian tracking of airborne particles with an electrohydrodynamic volume of fluids (VOF) simulation of the continuum aerodynamic and electrostatic fields around a droplet-loaded charged fiber. This new simulation approach allows one to predict aerosol filtration efficiency of charged fibers in the presence of moisture or when loaded with solid particles. In particular, our simulations revealed that deposition of liquid droplets on a fiber results in fiber charge neutralization and that higher droplet permittivity leads to a stronger fiber charge shielding. Our simulation approach offers a predictive tool for engineering next generation electret filters for respiratory protection and HVAC filter that can operate in high-humidity environment.

9CM.23

Realistic Simulation of Electrostatically Charged Filters on Micro- and Macro-Scales. HOOMAN V. TAFRESHI, Amit Kumar, Behnam Pourdeyhimi, *North Carolina State University*

We propose a new approach to simulate the pressure drop and particle capture efficiency of electrostatically charged fibrous filters on different scales. Our microscale (fiber-level) approach is centered on creating a realistic three-dimensional model of a filter's internal microstructure and using this geometry as the computation domain to solve the Navier-Stokes and Laplace equations and thereby obtain the aerodynamic and electrostatic fields around the charged fibers. The capture efficiency of the filters is then obtained using the Lagrangian (for large particles) and Eulerian (for nanoparticles) methods. Our macroscale approach is designed to extend the findings of the microscale model to dimensions that are comparable to the dimensions of the filter (i.e., filter thickness) without needing to run CPU-intensive simulations. The macroscale simulations also allow one to study the design pleated electret filters that are optimized for operation under dust loading. The pros and cons of each simulation method are discussed in reference to published studies in the literature.

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9CM.24

CFD Simulation of Simultaneous Gas and Aerosol Filtration from Wildfire Smoke. Mostafa Jafari Gildeh, HOOMAN V. TAFRESHI, *North Carolina State University*

Wildfire contains particulate matter (PM) and volatile organic compounds (VOCs), which can cause acute or chronic respiratory health effects. This work presents the first numerical simulation of simultaneous PM and VOC filtration using a fibrous filter. The simulated dual-functional filter is composed of electrostatically charged polymeric fibers for PM capture and activated carbon fibers (ACFs) for VOC adsorption. A microscale, fiber-resolved numerical framework is developed to evaluate the combined performance of this two-layered fibrous filter. Because the carbon fibers are microporous, adsorption at internal sites is assumed to be rapid relative to the intrafiber diffusion, while equilibrium uptake is described using a toluene adsorption isotherm as a representative VOC. Particle transport and capture on the charged polymeric and neutral carbon fibers are modeled using a combination of Eulerian (for nanoparticles) and Lagrangian (for large particles) approaches that accounts for the mechanical and electrostatic filtration mechanisms. Our simulation framework enables simultaneous assessment of VOC and PM filtration efficiencies as well as the effects of filter's microstructural parameters on its performance.

9CM.25

Numerical Modeling of Toluene Adsorption in Bidisperse Packed Beds of Granular Activated Carbon. Mostafa Jafari Gildeh, HOOMAN V. TAFRESHI, *North Carolina State University*

Granular activated carbon (GAC) is commonly used to remove various gases and vapors, including Volatile organic compounds (VOCs), from air because of its low cost and its high adsorption efficiency. In this study, we present a particle-resolved simulation framework to investigate how the packed-bed microscale geometry can be designed to improve VOC adsorption. We used toluene as the VOC in this study because of its structural similarity to other hazardous hydrocarbons. The model explicitly resolves individual particles and solves species transport in both the solid adsorbent particles and the pore spaces between them. This allowed us to study how different bidisperse bed configurations could affect the bed's breakthrough behavior. For the microporous adsorbent particles considered, intraparticle diffusion was treated as the rate-limiting mechanism. A unique attribute of the proposed approach is that it can capture the nonuniform, nonconcentric toluene loading inside the particles, which is not available in conventional reduced-order models. The simulations indicated that breakthrough curves for bidisperse packed beds composed of coarse and fine particles fall between those of the monodisperse packed beds made of the same particles. A comparison of the fully blended and layered particle configurations showed that the blended configuration better delayed breakthrough, followed by the layered configuration in which the coarse particles were placed on the upstream side.

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9CO.1

PFAS Emissions from Thermally Stressed Textiles. BRITTANY STINGER, *National Institute of Standards and Technology*

Per- and polyfluoroalkyl substances (PFAS) are used ubiquitously in household items to add water repellency and stain resistance to products. For example, carpets, carpet padding, and furniture may contain a PFAS coating or PTFE membrane. Additionally, PFAS are linked to various adverse health effects. Therefore, characterizing and quantifying PFAS released from materials are important to understand exposure risks. Some studies have quantified PFAS from indoor air by using thermal desorption (TD) tubes and other methods of air collection. However, studies have not looked at PFAS released from these materials when exposed to thermal stressing, like in the event of a fire. During and after a house fire, PFAS may be transformed by thermal degradation and transported in the gaseous phase and via soot. Exposure risk to first responders may come from inhalation and exposure to soot during and after a fire as PFAS are known to persist. To quantify PFAS emissions on a small scale, we measure the PFAS emissions from upholstery textiles stressed at temperatures ranging from 25°C - 600°C in a tube furnace. Fabric samples were placed in a quartz tube and heated to 25°C, 200°C, 400°C, or 600°C in a tube furnace. TD tubes and soot were collected during the sample run. Methanol wipes were collected after the sample run for chemicals deposited on the quartz tube. A solid phase extraction (SPE) method for soot and methanol wipes was developed and extracted PFAS were analyzed with a targeted analyte list of 55 PFAS analytes consisting of volatile, semivolatile, and nonvolatile PFAS. Characterization and quantification of PFAS from various collection methods (soot, methanol wipes, and TD tubes) will be discussed.

9CO.2

Generating and Characterizing Smoke Aerosol for HEPA Filter Media Loading. DRAKE LARSON, Jaime Gibson, Spencer Phillips, *Mississippi State University*

The Institute for Clean Energy Technology (ICET) at Mississippi State University (MSU) performs applied research regarding HEPA filter performance for the Department of Energy nuclear complex. One area of interest is HEPA capability during fire scenarios. Currently there is little data available. More thorough data is needed to support facilities in safely planning for fire scenarios.

The Flat Media Loading System (FMLS1) was designed to fill the void in the context of fire and soot behavior by reducing the time and resources it takes to fully characterize assembled AG-1 filters. This system's focus is collecting performance characterization data of flat media samples of AG-1 HEPA filter media.

A miniature Combustion Aerosol Standard soot generator (miniCAST) was chosen for this research. The miniCAST allows fine control of the particle geometric mean diameter with good stability. However, a few difficulties have presented themselves in this application.

This work has shown that the particle size of the output soot changes drastically when diluted. This is likely due to a chain of chemical reactions in newly formed soot particles. This issue was discovered due to a need for dilution of samples to prevent exceeding the concentration limit of the particle sizing instrument (Scanning Mobility Particle Sizer). It was found that changing the dilution ratio changes the particle size greatly. This led to the need for a soot growth chamber, to allow an appropriate residence time for the soot to agglomerate and form matured particles. Changing the dilution ratio now has minimal effects on resulting particle size distributions. As dilution is still needed for sizing, the aerosol challenge presented to the filter media samples is also diluted, resulting in slow loading results. This presentation presents work performed to increase filter loading times by understanding the relationship between soot aerosol before and after dilution.

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9CO.3

Quantifying and Minimizing the Environmental Impact of Agricultural Plastic Mulch Film Burning. AMIR REZA SHARAFUDDIN, Courtni Spencer, Kazi Habib, Sungyoon Jung, Yang Wang, *University of Miami*

Agricultural plastic mulch film, a widely used plastic material for soil coverage to enhance crop yields, presents increasing issues in its waste management due to the bulk size of the used plastic material and soil and chemical contamination. The open burning of plastic mulch film, currently allowed in the States of Florida, Iowa, and several other states, could release harmful air and soil pollutants, including microplastics, posing risks to the environment and human health. In this study, we aim to quantify and minimize the environmental impact of plastic mulch film burning through a series of controlled laboratory burning experiments. Samples of field-collected used plastic mulch film with entrained soils are burned in a tube furnace reactor, and the emitted air and soil pollutants are characterized by a set of online and offline instruments. We further identify combustion conditions (including burning temperature, combustion efficiency, and method of burning) that could reduce the pollutant emission and minimize the environmental and potential health impacts. Our preliminary data shows that burning the plastic mulch at higher temperatures (785 ℃ vs 585 ℃) leads to higher modified combustion efficiency (MCE), but at the same time, results in higher emission of air pollutants and microplastics in the burned residues. The emission factors for PM, SO_2, NO_x, and microplastics at the burning temperature of 785 ℃ are estimated to be around 3.0, 3.4, 8.4, and 5.8 times of those under 585 ℃. Based on the preliminary data so far, treating the plastic mulch under lower temperatures with shorter durations may help with minimizing the bulk size of the waste and environmental pollution. The findings will inform stakeholders about the environmental risks of open burning and provide evidence-based recommendations for agricultural plastic management practices.

9CO.4

Effects of Combustion Conditions on the Emissions of Reactive Nitrogen in Simulated Wildland Fires. MUHAMMAD ABDURRAHMAN, Michael Caraway, Thomas Carroll, Nicholas Kusumo, Kruthika Kumar, Anita Anosike, Ariana Deegan, Vignesh Vasudevan Geetha, Shanhu Lee, Ed Fortner, Mac A. Callaham, Joseph O'Brien, Amanda Frossard, Rawad Saleh, *University of Georgia*

Reactive nitrogen (Nr) plays important roles in shaping the atmospheric oxidation and particle formation chemistry associated with emissions from wildland fires. We examined the dependence of Nr emissions on combustion conditions for burns representative of Southeastern wildland fires, as part of the second Georgia Wildland Fire Simulation Experiments (G-WISE-2). We conducted combustion experiments using fuel beds with variable mass loadings, moisture contents, and compositions (surface fuels only or with duff underlying the surface fuels). Consistent with previous reports, we found that NOx (NO and NO2) comprised the majority of the total measured Nr species by mass (53% - 98%), followed by particulate organic nitrogen (Org-N) (1% - 19%), NH_3 (1% - 8%), NO_3^- (0.2% - 4%), and NH_4^+ (0.1% - 3%). The wide ranges of Nr relative partitioning across the different species reflect variability in combustion conditions, assessed using modified combustion efficiency (MCE) and black carbon to organic aerosol ratio (BC/OA). Specifically, less efficient combustion (low MCE and BC/OA) associated with an increase in dry mass loading and moisture content of the surface fuels, or inclusion of duff in the fuel bed, led to an increase in NH_3 and Org-N emission factors, and a decrease in NOx emission factors. For fuel beds that contained surface fuels only, NH_4^+ and NO_3^- followed the same increasing trend with decreasing combustion efficiency as NH_3 and Org-N, but fell below the trend for fuel beds that contained duff. This is likely because duff combustion favors partitioning fuel nitrogen into Org-N and NH_3 over NH_4^+ and NO_3^-. Overall, these findings illustrate the importance of variability in combustion conditions that ensue from the interplay between fuel-bed composition and environmental conditions in dictating the partitioning of Nr in smoke emissions from wildland fires.

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9CO.5

Towards Radiative Energy-Based Emission Estimates for Wildland Fires. L.-W. ANTONY CHEN, Olusanya Onamuti, Patrick Martens, *University of Nevada, Las Vegas*

Wildland fires are major sources of atmospheric gases and carbonaceous aerosols, with important implications for air quality, climate, and human exposure. Emission estimates are commonly based on fuel consumption models and bulk emission factors, but uncertainties result from varying combustion conditions across fuel types and burn phases (e.g, flaming versus smoldering). Fire radiative power (FRP) and fire radiative energy (FRE) provide a direct, real-time measure of combustion energy release and have strong potential for improving wildfire emission estimates from ground-based, drone-based, and satellite thermal imagery. However, total FRP/FRE alone may not fully capture differences in combustion regime that influence emission composition. This study examines the relationship between thermal-imaging-derived FRP/FRE, fuel mass loss, and gas/particle emissions using combustion chamber experiments as part of the Harnessing the Data Revolution for Fire Science (HDRFS) project. Fuels representative of the Great Basin ecosystem, including Ponderosa pine, sagebrush, and rabbitbrush, were burned under controlled conditions. Real-time plume measurements included CO_2, CO, NO_x, SO_2, black carbon, and brown carbon, with the fuel mass continuously monitored. Radiometric thermal images were recorded and processed to derive pixel-level FRP, which was further grouped into 20°C temperature bins from 100 to 800°C to characterize the temperature-FRP distribution. Preliminary results show that gas and particle concentrations tracked FRP dynamics across burn experiments. Fuel mass loss followed cumulative CO_2, supporting carbon mass balance-based emission estimation. Importantly, the temperature-resolved FRE distributions revealed clear contrasts between fuel types. For example, Ponderosa duff with higher moisture content released a larger fraction of energy at lower combustion temperatures, consistent with extensive smoldering combustion, whereas drier sagebrush showed a higher-temperature energy distribution characteristic of dominant flaming phase. These differences highlight the potential to improve predictions of combustion efficiency and phase-specific emissions from temperature-resolved FRP/FRE measurements.

9CO.6

The Effect of Variable Combustion Conditions in Prescribed Fires on Emission Factors of Smoke Constituents. MICHAEL CARAWAY, Muhammad Abdurrahman, Nicholas Kusumo, Thomas Carroll, Kruthika Kumar, Anita Anosike, Ryan Poland, Mike Lesiak, Mac A. Callaham, Geoffrey Smith, Joseph O'Brien, Rawad Saleh, *University of Georgia*

Emission factors of smoke constituents in wildland fires exhibit high variability, often attributed to differences in fuel type and combustion conditions. During the second Georgia Wildland-fire Simulation Experiment (G-WISE-2), we investigated how variabilities in fuel-bed composition (i.e., fuel type), dry mass loading, and environmental conditions (wind speed and moisture content), manifest as differences in combustion conditions, and consequently smoke emissions. Fuel-bed characteristics and environmental conditions were varied within ranges that span the lower and higher ends of the prescription window for prescribed fires in the Southeastern U.S.

For fuel beds that contained surface fuels only, increase in dry mass loading and/or moisture content led to less efficient combustion, characterized by decreases in modified combustion efficiency (MCE) and the ratio of elemental carbon to organic carbon (EC:OC). The most drastic effect on combustion conditions was associated with the inclusion of duff in the fuel bed. Compared to fuel beds that contained surface fuels only, the duff fuel beds had (1) lower MCE (0.843 ± 0.003 vs 0.954 ± 0.003) and EC:OC (0.012 ± 0.002 vs 0.119 ± 0.026); (2) higher emission factors of incomplete combustion products, including CO (by 231%), aromatics (by 70%), and particulate matter (by 88%); and (3) lower NOx emission factors (by 77%).

To address whether the difference in emission factors between duff and surface fuels was due to fuel type or combustion conditions, we included an experimental fuel bed ("faux duff') that featured compacted surface fuels with high moisture content to induce combustion conditions similar to duff. Emissions of all smoke constituents from faux duff were much closer to duff than the other surface fuels. Given the profound compositional difference between surface fuels and duff, this finding indicates that combustion conditions can be a practical predictor of wildland fire smoke emissions regardless of fuel type.

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9CO.7

Height-Resolved Composition, Mixing State, Morphology, and Size Distributions in Prescribed-Fire Flames and Near-Field Plumes. ALLA ZELENYUK, Schuyler Lockwood, Amna Ijaz, Zezhen Cheng, Swarup China, David Weise, Joey Chong, Stephen Baker, Emily Lincoln, Shawn Urbanski, Georgios Karavalakis, Zisimos Toumasatos, Tracy Baker, Ashley Bradley, Kendall Hughey, Timothy Johnson, David Lignell, *Pacific Northwest National Laboratory*

Accurate prediction of wildland fire smoke requires linking fuel properties and combustion dynamics to the physicochemical evolution of emissions within the flame and into the near-field plume. While lofted smoke has been widely characterized, key uncertainties remain in how particle size, composition, and mixing state evolve across the fuel bed, flame, and immediate plume, where initial particle formation and rapid transformation occur.

We report results from a combined dataset of over 115 experimental fires in pine needle beds conducted at the U.S. Forest Service's Riverside and Missoula Fire Laboratories. Burns included longleaf and ponderosa pine needles at high and low moisture content, and both line and stationary circular fire geometries.

Emissions were sampled at multiple fixed heights spanning the persistent (pyrolysis), intermediate (intermittent flaming), plume (above-flame smoke), and stack (15 m) regions, enabling characterization across pyrolysis, flaming, and smoldering stages. Gas-phase species were measured by Fourier transform infrared spectroscopy. Particle properties (size, composition, effective density, shape and morphology individual particles) were measured by single-particle mass spectrometer, miniSPLAT, complemented by an Engine Exhaust Particle Sizer (5–560 nm) for concentration and mobility size distributions, and offline filter analysis by high-resolution mass spectrometry and microscopy.

Particle number concentrations and size distributions varied strongly with sampling zone, with the highest concentrations consistently observed in the persistent region. miniSPLAT revealed pronounced height-dependent changes in particle mixing state and morphology. Single-particle mass spectra were classified into ~100 classes and consolidated into distinct particle types showing internally mixed contributions of elemental carbon (EC), ash, polycyclic aromatic hydrocarbons (PAHs)/organics, and fullerene-like carbon using custom SpectraMiner software. Persistent-zone particles exhibited substantially higher organic/PAH fractions (consistent with bulk OC/TC measurements), and a mixed morphology of compact particles and fractal agglomerates. In contrast, intermediate and plume regions were dominated by fractal soot agglomerates with larger relative EC and ash contributions, though circular fires exhibited more organic-rich particles aloft than line fires. Differences in mass loss rate between circular and line fires corresponded to systematic shifts in particle composition and morphology.

These results demonstrate that near-source particle properties are highly nonuniform with height, fuel type/moisture, and fire geometry, and should be explicitly represented in models that couple fire behavior to smoke emissions and evolution.

9CO.8

Prospective Assessment of Diesel I/SVOC Emissions Under the China VII-Oriented Technology Route. XIAO ZHANG, Shaojun Zhang, *Tsinghua University*

Intermediate- and semi-volatile organic compounds (I/SVOCs) emitted from diesel engines are important precursors of secondary organic aerosol (SOA), yet their response to next-generation emission-control technologies remains poorly understood. Here, we performed engine-based measurements to provide a prospective evaluation of diesel I/SVOC emissions under the China VII-oriented technology route. Because vehicle-level China VII measurements are not yet available, this study is intended to identify likely control trends rather than serve as a direct vehicle-to-vehicle regulatory comparison.

Compared with the China VI reference configuration, the China VII-oriented configuration showed significant reductions in total I/SVOC emissions, with more pronounced reductions under cold-start-sensitive conditions. Total I/SVOC emissions decreased by 64%, while cold-start and hot-start stages decreased by 84% and 52%, respectively. Composition-resolved analysis indicated that hydrocarbon species were preferentially reduced, with alkanes and aromatics decreasing by 75% and 91%, respectively. In contrast, oxygenated compounds exhibited a smaller reduction, resulting in an increased relative contribution to the residual emissions.

Volatility-resolved analysis further revealed that low-volatility SVOCs were more effectively suppressed than IVOCs. The IVOC/SVOC ratio increased from 1.6 to 3.1, indicating a clear restructuring of the volatility distribution toward higher-volatility bins. This pattern suggests that the China VII-oriented technology route, likely through faster low-temperature aftertreatment activation and improved control of condensable heavy organics, may preferentially suppress low-volatility, SOA-relevant precursors. The preferential suppression of low-volatility SVOCs further implies a disproportionate reduction in SOA-relevant organic precursors compared with total I/SVOC mass. Estimated SOA formation potential decreased more strongly than total I/SVOC mass, highlighting the enhanced climate- and air-quality relevance of the China VII-oriented control pathway.

These results indicate that the China VII-oriented technology route may not only reduce total diesel I/SVOC emissions, but also reshape their chemical composition and volatility distribution in a direction more favorable for mitigating SOA precursor emissions. The study provides an early perspective on the likely benefits of next-generation diesel control technologies for organic aerosol precursor reduction.

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9CO.9

Equivalent Particle Sizes of Soot Aggregates Accounting for Primary Particle Growth: Implications for Aerosol Dynamics Modeling. Steven Rogak, Sung Hoon Park, NISHAN SAPKOTA, *University of British Columbia*

Soot aerosol dynamics models require an accurate representation of aggregate morphology while maintaining computational efficiency. Conventional sectional approaches either employ computationally expensive bivariate formulations that explicitly track both particle mass and aggregate morphology or assume a uniform primary particle diameter, neglecting the experimentally observed growth of primary particles during soot evolution. In this study, an analytical framework is developed that incorporates primary particle size variability into sectional aerosol dynamics modeling by exploiting the universal correlation between primary particle diameter and aggregate mobility diameter proposed by Olfert and Rogak (Aerosol Science and Technology, 53, 485-492, 2019). Analytical expressions are derived for the primary particle diameter, mobility diameter, and collision diameter as functions of particle mass. Unlike formulations assuming a constant primary particle diameter, the proposed model predicts increasing primary particle size with aggregate growth, producing mobility and collision diameters between the limiting cases of spherical particles and fractal aggregates with uniform primary particles. The analytical predictions are evaluated against SOOTSECTION, a one-dimensional bivariate sectional model that simulates soot coagulation, surface growth, and primary particle evolution in a jet-stirred reactor/plug-flow reactor system. The predicted primary particle, mobility, and collision diameters agree well with the analytical expressions throughout particle growth. This agreement supports the hypothesis that the experimentally observed correlation between primary particle size and aggregate size arises primarily from surface growth and may therefore be applicable to a wide range of combustion sources. The proposed framework enables aggregate morphology to be prescribed analytically, eliminating explicit morphology tracking in sectional aerosol dynamics models. This simplification provides a practical means of substantially improving the computational efficiency of numerical soot simulations while preserving physically realistic predictions of aggregate properties.

9CO.10

Characterization and Toxicity Assessment of Particulate Matter Emitted from a Gas Turbine Combustor Operating on Conventional and Alternative Liquid Fuels. MA CRISTINE FAYE DENNA, Ishan Gupta, Seongbin Jo, Minhan Park, Maksim Kvetny, Benjamin Emerson, Nga Lee Ng, Rodney J. Weber, Eladio Knipping, *Georgia Insitute of Technology*

Gas turbines are widely used for electric power generation. While commonly operated with natural gas, a focus on green liquid fuels is also being explored. Little is known about the particulate matter (PM) emitted during combustion of these different liquid fuels. This study characterizes the primary particulate emissions from a high-pressure combustion test rig operated on diesel, renewable diesel, jet fuel, sustainable aviation fuel (SAF), and ethanol, and evaluates their toxicity. A heated sampling system was optimized to collect nonvolatile PM on quartz filters for subsequent carbonaceous species characterization and toxicity assessment using both acellular and cellular assays. Preliminary findings show that diesel produced the highest carbonaceous PM loading per mass of fuel burned (OC: 0.030 μg cm^{-2} g^{-1}, EC: 0.030 μg cm^{-2} g^{-1}), followed by jet fuel and renewable diesel, while SAF produced the lowest carbonaceous loading (OC: 0.020 μg cm^{-2} g^{-1}, EC: 0.007 μg cm^{-2} g^{-1}). Despite lower carbon loading, jet fuel exhibited the highest intrinsic oxidative potential (OPm) measured by the dithiothreitol (DTT) assay, followed by renewable diesel, SAF, and diesel. These values fall within the range of previously reported OPm values from different combustion sources. Intracellular reactive oxygen species (ROS) measurements showed that combustion-derived PM induced two-fold greater oxidative response than equivalent ambient PM mass concentrations, with diesel producing the highest response, followed by renewable diesel and jet fuel. Additional experiments under lean and rich combustion conditions will be presented to further evaluate the influence of operating conditions on PM composition and toxicity. These findings improve the understanding of PM emissions and potential oxidative toxicity from gas turbine combustion using conventional and alternative fuels and provide data for evaluating the environmental and health impacts of future fuel transitions.

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9HR.1

Age-Resolved Respiratory Deposition of Secondary Organic Aerosols from Coupled Indoor-Outdoor VOC Precursors and Trimethylamine. HYEON-JU OH, Jaewon Seo, Jihye Moon, Hwajin Kim, *Seoul National University*

Indoor environments are influenced by indoor emissions, infiltrated outdoor pollutants, and reactive gas-phase species that collectively contribute to secondary organic aerosol (SOA) formation and human exposure. However, the combined effects of indoor–outdoor volatile organic compounds (VOCs) and gas-phase amines on SOA formation and respiratory exposure remain poorly understood. This study investigated SOA formation and age-resolved respiratory deposition using α-pinene and toluene as representative indoor–outdoor VOC precursors with and without trimethylamine (TMA) as a gas-phase amine additive.

Experiments were conducted in a controlled flow reactor (RH 30 ± 5%) coupled with a Potential Aerosol Mass (PAM) reactor to simulate atmospheric aging. Particle size distributions and chemical composition were characterized using a Scanning Mobility Particle Sizer (SMPS) and an Aerosol Mass Spectrometer (AMS). Generated aerosols were introduced into a human-mimetic inhalation exposure system, and size-resolved respiratory deposition was estimated using the Multiple-Path Particle Dosimetry (MPPD) model for a 3-year-old child and a 21-year-old adult.

Under comparable conditions, α-pinene produced substantially greater SOA mass than toluene, while TMA altered SOA formation and particle characteristics, indicating the influence of gas-phase amines on aerosol evolution. Despite differences in SOA production, respiratory deposition was governed primarily by particle size distribution rather than precursor composition. Although deposition efficiencies were similar between children and adults, children received greater inhaled and deposited doses because of their higher ventilation rates relative to body size. Most particles remained within the PM_1 size range, indicating efficient transport to the distal lung. These results demonstrate that respiratory exposure to indoor SOA is governed by coupled indoor–outdoor precursor chemistry and particle size evolution rather than aerosol mass alone.

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9HR.2

Characterizing Wood Dust Particle Size Distribution and Respirable Dust by Sawmill Processes and Wood Types. DONGWON KIM, Sungwon Choi, Kyung Sook Woo, *Institute of Occupation and Environment, KCOMWEL*

Current occupational exposure limits for wood dust in South Korea are based on inhalable mass concentration; however, characterizing respirable dust is crucial for preventing diseases like chronic obstructive pulmonary disease (COPD). This study investigated the mass and real-time number concentrations of wood dust to identify generation characteristics by sawmill process and wood type. We evaluated two sawmills: Sawmill A handling softwood with a 3-stage cutting process, and Sawmill B handling hardwood with a 5-stage process including molding and sanding. Gravimetric analysis was used to measure inhalable and respirable dust, while an Optical Particle Sizer (OPS) was used to determine real-time number concentrations and particle size distributions.

Results indicated that inhalable dust concentration was highest during the band saw process (GM 2.890 mg/m3), whereas respirable dust was highest in the precision molding process (GM 0.056 mg/m3). Processing hardwood generated approximately 2.1 times higher respirable dust concentrations compared to softwood. Importantly, while the respirable portion accounted for only 0.5-2.8% of the total mass, the number concentration data showed that over 99% of the particles were within the respirable size range (<= 4 micrometer). These findings highlight a significant discrepancy between mass and number concentrations. Because conventional mass-based standards may underestimate worker exposure to fine particles, adopting number concentration as a complementary metric is recommended for evaluating the health risks of wood dust.

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9HR.3

Quantifying Cellular Impacts of Aerosol Exposure Using Automated Live-Cell Fluorescence Imaging. Akhil Kota, Karin Ardon-Dryer, Alexandria Johnson, Lauryn Fox, GOURI PRABHAKAR, *Purdue University*

Outdoor and indoor air pollution has been shown to contribute to adverse human health outcomes, including premature mortality. Inhalation of fine particles can lead to a wide range of health impacts depending on the physiochemical characteristics of these particles. Much of our current understanding of these effects is based on scientific studies based on simulations, animal models, and in-vitro experiments with bulk analyses. These methods lack the spatial and temporal resolution to capture the cell-particle dynamics occurring over short time scales (minutes to a few hours).

Live-cell fluorescence microscopy is a powerful method to observe the short-timescale dynamics in live-cell systems exposure to varying levels of particle loading. One of the main challenges of single studies is the long and labor-intensive nature of manual analysis of large microscopy image datasets generated by such experiments. This has limited the scope and reproducibility of such exposure studies. Recent advances in deep learning have greatly benefited the health sciences through software that can perform cell segmentation and tracking on microscopy images. These not only enable cell tracking throughout the experiment but also provide useful morphological characteristics of individual cells.

In this study, we evaluate the performance of open-source deep learning-based software tools – Cellpose-SAM for cell segmentation and TrackMate7 for cell tracking – on dust-laden live lung cell fluorescence microscopy images. We assess their robustness under particle-loaded imaging conditions and demonstrate their ability to extract quantitative, multi-parametric cellular responses. This workflow could support scalable and reproducible experiments to quantify cellular response to toxic microenvironments, and advance health studies.

9HR.4

Daytime and Nighttime Atmospheric Oxidation of Cyanobacterial Aerosols: Impacts on Oxidative Potential and Chemical Composition. ANTHONY CHUNG, Myoseon Jang, *University of Florida*

Cyanobacterial aerosols emitted from harmful algal blooms can pose respiratory health risks through inhalation of algal toxins and redox active organic matter. Although atmospheric oxidation can rapidly degrade microcystin LR in cyanobacterial aerosols, the same aging process may also form oxidized products that change aerosol oxidative potential. However, it remains unclear whether nighttime aging by ozone and nitrate radicals reduces aerosol toxicity through microcystin LR degradation or maintains oxidative potential through the formation of oxidized products. Cyanobacterial aerosols were introduced into the chamber to mimic the atmospheric aging of algal aerosols. This study investigates the daytime and nighttime atmospheric oxidation of chamber-generated cyanobacterial aerosols in the presence of hydroxyl radicals, ozone, and nitrate radicals under different NO_x and humidity conditions. The study analyzes microcystin LR degradation, microcystin oxidation products, and aerosol oxidative potential, in addition to algal spectroscopic properties measured by particle absorbance and fluorescence. These measurements determine how toxin loss, oxidized product formation, and oxidative stress evolve during atmospheric aging. The oxidative potential of chamber-generated cyanobacterial aerosols was measured using acellular assays (i.e., dithiothreitol and ascorbic acid) to assess different oxidative pathways and mechanisms. This study improves understanding of how cyanobacterial aerosols and associated toxins dynamically change during daytime and nighttime atmospheric chemistry. The comparison between daytime and nighttime oxidation shows whether oxidants can degrade microcystin LR while maintaining or enhancing oxidative potential and changing the chemical composition of cyanobacterial organic matter.

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9HR.5

Chemically Resolved Respiratory Deposition of Urban Ultrafine Particles Characterized by Number Concentration.

JINGHAO ZHAI, Yaling Zeng, Xin Yang, *The University of Chicago*

Ultrafine particles (UFPs) dominate the atmospheric particles in number concentration, impacting human health and climate change. However, existing studies primarily rely on mass-based approaches, leading to a restricted understanding on the number-based and chemically-resolved health effects of atmospheric UFPs. In this study, we utilized a high mass-resolution single particle aerosol mass spectrometer to investigate the online chemical composition and number size distribution of ultrafine, fine, and coarse particles during the summertime in urban Shenzhen, China. Human respiratory deposition dose assessments of particles with varying chemical compositions were further conducted by a respiratory deposition model. The results showed that during our observation, particles containing elemental carbon (EC), were the dominate components in UFPs (0.05–0.1 μm). Compared to fine and coarse particles, UFPs can deposit more deeply into the respiratory tract with a daily number dose of ~2.08 ± 0.67 billion particles. Among the deposited UFPs, EC-cluster particles constituted ~85.7% in number fraction, accounting for a daily number dose of ~1.78 billion particles, posing a greater impact on human health. Simultaneously, we found discrepancies in the chemically-resolved particle depositions between number-, surface area-, and mass-based approaches, emphasizing the importance of an appropriate metric for particle health-risk evaluation.

9HR.6

Acetylation Drives Ketene Formation in Cannabinoid Vape Aerosols.

Rhianna Evans, NOEL CORLEY, Haylee Hunsaker, Sascha Nicklisch, Allison Ehrlich, Tran Nguyen, *University of California, Davis*

Electronic cigarette use for cannabinoid delivery has increased rapidly, including acetylated cannabinoids that are structurally similar to vitamin E acetate, a compound previously linked to lung injury. These acetylated compounds are thought to form the highly reactive pulmonary toxicant ketene during vaping, but quantitative data across commonly used cannabinoids under realistic vaping conditions are still limited. Here, we optimized an impinger-based sampling method to improve ketene trapping efficiency and used it to quantify ketene and carbonyl formation across a range of conventional and emerging cannabinoid distillates using a commercially available vape device. Ketene was detected from all O-acetylated cannabinoids but not from their non-acetylated analogues, confirming that the acetyl group is the primary source of ketene formation. Measured ketene yields ranged from 0.8-4.3% by cannabinoid mass, with the highest production observed for cannabidiol di-O-acetate, likely due to the presence of multiple acetate groups and increased structural reactivity. Total carbonyl production ranged from 0.1-1.5% for acetylated cannabinoids and up to 7% for non-acetylated compounds, suggesting that carbonyl formation is not limited to acetyl group decomposition. Device operation also influenced toxicant formation. Reduced airflow increased ketene yields, while increased airflow increased carbonyl production, indicating different roles for temperature and oxygen. Estimated ketene concentrations per puff exceeded established safety thresholds, highlighting potential health risks associated with vaping acetylated cannabinoid products. These results show that both chemical structure and user behavior influence toxicant exposure and point to the need for improved regulation of emerging cannabinoid formulations.

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9HR.7

Coil Material and Nicotine Salt Formulation Drive Toxic Metal Leaching and Aerosolization in Open-System Electronic Nicotine Delivery Systems (ENDS). CHARBEL HARB, Karmann Riter, Norman Urbanek, Jacob Hilldrup, Ethan Sill, Jonathan Thornburg, Felicia L. Shelton, Yuan-wei Nei, Anjali Verma, Michael Morschauser, Lee Williamson, *RTI International*

Open-system (mod-style) electronic nicotine delivery systems (ENDS) offer users a more customizable alternative to cartridge or pod-style closed systems, often including the option to change coil type, material, or configuration. However, this increased customizability raises concerns about how specific device characteristics, particularly heating coil material and nicotine formulations, influence heavy metal transfer into e-liquids and aerosols. In this study, we used a mod-style device (SMOK RPM 40) to evaluate how coil material (ceramic, nickel, and nichrome) and nicotine salt chemistry (benzoic and lactic acid) affect the leaching of cadmium (Cd), chromium (Cr), nickel (Ni), and lead (Pb) into e-liquid during 14 days of storage without device activation. The devices were also machine puffed using a linear smoking machine (Cerulean SM-450) following CORESTA Method 81 parameters for up to 2,800 puffs to determine metal concentrations in aerosols. We quantified metal concentrations in both e-liquid and aerosol samples using inductively coupled plasma–mass spectrometry (ICP-MS). Results showed that storage without activation for up to 14 days caused substantial enrichment of metals in e-liquid, with notable leaching of Ni (823 µg/kg) and Pb (427 µg/kg) in devices equipped with a ceramic coil and lactic acid. Aerosol metal concentrations differed by coil type and were generally greatest during the first 1,000 puffs, suggesting elevated metal aerosolization from newly installed coils. Consistent with recent studies, lactic acid increased metal leaching into both e-liquid and aerosols by as much as an order of magnitude compared to benzoic acid. Comparing metal concentrations in e-liquids and aerosols over the same device storage period indicated that coil heating during machine puffing was the main driver of metal aerosolization, and not metal leaching associated with device storage. Overall, these findings clarify how heating element composition and nicotine salt chemistry drive toxic metal exposure from mod-style ENDS devices.

9HR.8

Spatial Variability in PM2.5 Oxidative Potential Across the Global Scale. YUHUI ZHAI, P. S. Ganesh Subramanian, Sudheer Salana, Christopher Oxford, Xuan Liu, Yuxuan Ren, Randall Martin, Vishal Verma, *University of Illinois Urbana−Champaign*

Ambient fine particulate matter ($PM_{2.5}$) is a major environmental risk factor for adverse health outcomes, yet particle mass concentration (PMC) alone may not fully represent the PM-induced health impacts. Oxidative potential (OP) provides a complementary metric by quantifying the capacity of $PM_{2.5}$ to generate reactive oxygen species, thereby linking aerosol chemistry more directly to oxidative stress. However, the spatial variability of $PM_{2.5}$ OP and its relationship with PMC and chemical composition remain insufficiently characterized across globally distributed monitoring sites.

This study investigates inter-continental variations in $PM_{2.5}$ OP using the samples collected from the Surface Particulate Matter Network (SPARTAN). A total of 271 $PM_{2.5}$ samples collected from 10 sites across Asia, Africa, North America, and South America between 2021 and 2024 were analyzed. OP was quantified using the dithiothreitol (DTT) assay and expressed as mass-normalized oxidative potential (OP_m), representing intrinsic OP, and volume-normalized oxidative potential (OP_v), representing exposure-relevant oxidative burden. Coefficients of variation (CoV) were used to compare relative variability among PMC and OP metrics. Spearman correlation analysis was applied to evaluate associations among OP_m, OP_v, PMC, and chemical constituents in $PM_{2.5}$.

Both OP_v and OP_m generally displayed more variability than PMC consistently across most sites, indicating that temporal changes in aerosol oxidative characteristics arising from variability in chemical composition are not fully captured by changes in PMC alone. Correlation analysis further showed that OP_v was more strongly associated with OP_m than with PMC consistently in 7 out of the 10 sites. Site-specific correlations with chemical components indicate spatial variability in the chemical drivers and the resulting sources of OP across the global scale. Collectively, these results indicate that overall exposure to the health-relevant PM metrics such as OP is more likely to be driven by variations in chemical composition of PM, rather than mass concentration of the particles. We are currently analyzing these samples for the hydroxyl radical generation potential (OP^{OH}) and anticipate those results to complement the OP^{DTT} responses.

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9HR.9

Exploring the Role of Secondary Organic Aerosol in In-vitro Exposures of Cell Lung Models. CHRISTINA VASILAKOPOULOU, Ambre Delater, Benjamin Simonneau, Thalles de Freitas Castro, Mathieu Cazaunau, Edouard Pangui, Damien Lopez, Prodip Acharja, Christopher Ferland, Lisa Guth, Bénédicte Picquet-Varrault, Guillaume Suarez, Sophie Lanone, Patrice Coll, *Université Paris Cité and Univ Paris Est Creteil, CNRS, LISA*

Atmospheric aerosols pose significant risk to human health as highlighted by the World Health Organization. Organic aerosol (OA) is one of the most important components of atmospheric particles with contributions up to 90% of the sub-micrometer aerosol mass. Secondary OA (SOA) is formed in the atmosphere during the oxidation of organic vapors and can dominate the total organic PM in particles with aerodynamic diameter of less than 1 µm (PM1) especially in warmer periods. Biogenic volatile organic compounds (VOCs) dominate global emissions and react rapidly in the atmosphere, thus playing a central role in SOA formation. Here we investigate in-vitro the health effects of SOA produced from the ozonolysis of a-pinene, a monoterpene with high emissions and relatively high SOA yield. Human bronchial epithelial (16-HBE) cells were cultured at the Air-liquid interface and exposed using the Vitrocell AirTox Monitor connected to the CESAM simulation chamber (4.2 m3). Particle phase composition and size-distribution were continuously monitored during the experiments using a HR-ToF-AMS and a DMPS. Gas phase was monitored with a PTR-MS and standard gas monitors (O3, NOx, CO, CO2), when oxidative potential was measured on-line through the experiment and off-line by sampling of the SOA on quartz filters (2h at 2 lpm). The exposure of the cells started after the SOA (O:C=0.40; H:C=1.60) stabilized at 200 ± 20 µg/m3 with unimodal size-distribution and lasted for 2 hours. Transepithelial electrical resistance was measured before and after the exposure to address the impact of the exposure to the cell's layer's integrity. Post-exposure analyses also included intracellular reactive oxygen species (ROS), cytotoxicity, and quantification of inflammatory markers (IL-8, IL-6, TNF-α, IL-1β). This work presents the first coupling of the CESAM chamber with an air–liquid interface exposure system, providing a controlled and atmospherically relevant platform to investigate SOA-induced health effects.

9HR.10

Physico-Chemical and Oxidative Properties of Particulate Matter Emitted from the Combustion of Conventional and Sustainable Aviation Fuels. ANSON REGI, Connor Malley, Sungho Hwang, Tonghun Lee, Vishal Verma, *University of Illinois Urbana-Champaign*

As the aviation industry expands, understanding the environmental and human health impacts of particulate matter (PM) from aircraft engines is critical. While Sustainable Aviation Fuels (SAFs) reduce overall PM mass and number, the influence of fuel chemistry on the physicochemical and toxicological properties of these particles remains poorly understood. This study investigates the influence of combustor equivalence ratio and fuel type on physicochemical properties, such as mobility diameter (D_m), elemental and organic carbon fractions (EC/OC), and oxidative potential (OP) of PM emitted from the combustion of conventional Jet-A and three SAFs.

The results indicate that across all fuel-rich conditions, SAFs consistently produced particles with peak D_m values 20–50% lower than those of conventional Jet-A. Across all tested fuels, the EC and OC fractions of PM showed a dependence on the equivalence ratio, which suggests an OC-dominant regime under fuel-lean conditions, while shifting towards EC-dominance in fuel-rich environments that promote pyrolysis. The potential toxicity of PM, measured as its intrinsic oxidative potential (OP), showed a more complex trend across equivalence ratios. In the OC dominant regime (i.e. EC<0.25 µg/µg of PM), OP showed a positive correlation with OC (R^2 = 0.30). However, as the EC fraction started to increase, OP showed a significantly positive relationship with EC (R^2 = 0.33).

Most importantly, while SAFs are known to significantly reduce PM mass and number, the potential toxicity of emitted particles was either equal to or exceeded that of conventional Jet-A. Consequently, understanding the complex relationships between fuel chemistry, particulate properties, and oxidative potential is essential for developing next-generation fuels that provide meaningful benefits to both the environment and public health.

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9HR.11

Investigation of Drug Delivery Rate and Droplet Size Distribution of Common Medical Nebulizers. Taewon Han, Antonio Baratta, Michael Falvo, Daniel P. Wilhite, GEDIMINAS MAINELIS, *Rutgers, The State University of New Jersey*

Accurate characterization of medical nebulizer performance is essential for proper delivery of therapeutic and diagnostic aerosols. This study assessed drug delivery rate (mg/min) and aerosol droplet size distribution (mass median aerodynamic diameter, or MMAD) for three commonly used nebulizers: AeroEclipse® II BAN™, Hudson RCI Micro Mist, and Vyaire Misty Max 10.

Drug output was quantified by connecting each nebulizer to a pulmonary function testing filter and breathing simulator, then measuring the mass of methacholine (Provocholine®) collected on the filter. The delivery rate depended on nebulizer type, aerosolization time, initial drug concentration, and fill volume. With a 2 mL fill of 16 mg/mL solution, the AeroEclipse II produced higher short-duration output (4.1 ± 0.1 mg/min at 20 s) than during longer operation (3.5 ± 0.01 mg/min at 2 min). Over a 2-minute interval, Hudson and Vyaire devices delivered lower outputs of 1.9 ± 0.2 and 1.7 ± 0.2 mg/min, respectively. For a 2-minute aerosolization duration, AeroEclipse II output exceeded manufacturer specifications by ~30%, likely reflecting the higher simulated tidal volume and inspiratory time.

Droplet size distributions were measured using an 8-stage Andersen impactor housed in a refrigerator to minimize evaporation. The mass of droplets captured on each stage was quantified by conductometry. At 16 mg/ml Provocholine®, AeroEclipse II generated the smallest MMAD (3.6 µm), followed by Vyaire (3.7 µm) and Hudson (4.1 µm). AeroEclipse II also produced the highest respirable fraction (PM5) at 59%, compared with 54% and 50% for the other devices. At room temperature, all nebulizers showed reduced MMAD and increased PM5 due to evaporation. For example, the PM5 fraction of AeroEclipse increased to ~70%.

These results demonstrate that nebulizer selection and operating conditions substantially influence delivered dose and droplet size distribution, with direct implications for methacholine challenge testing and respiratory disease evaluation.

9HR.12

Influence of Carrier Gas Composition and Dynamic Airway Motion on Aerosol Transport and Deposition in Human Respiratory Tract. HANG YI, Yu Feng, *Oklahoma State University*

Optimizing targeted pulmonary drug delivery requires a precise understanding of carrier gas aerodynamics and lung biomechanics. Standard rigid-wall computational lung aerosol dynamics models often neglect the physiologically realistic airway deformation kinetics, including the anisotropic glottis and tracheobronchial tree motion. Such a simplification limits the physiologically realistic nature of the computational fluid particle dynamics (CFPD) based airway models and may introduce errors in aerosol transport and deposition predictions. Therefore, this study investigates the combined effects of airway deformation kinetics and carrier gas mixtures, i.e., standard air, a hydrogen-oxygen blend (66.7% H2 and 33.3% O2), and heliox (70% He and 30% O2), on the transport and deposition of inhaled drug particles in a representative 3D mouth to generation 8 (G8) airway geometry. An experimentally validated CFPD model with one-way fluid-structure interaction (FSI) was utilized to simulate air-particle flow dynamics under realistic breathing conditions with simultaneous airway deformation kinetics prescribed. Deposition efficiencies (DE) were quantified and compared across a static rigid airway model and a moving airway model. In the meantime, the physicochemical impacts of carrier gases were evaluated systematically. Results show that the introduction of airway deformation kinematics altered deposition patterns of inhaled particles. In the air carrier environment, dynamic airway deformation reduced penetration of 1-um particles into distal airways (i.e., beyond G8), decreasing the overall global DE for standard air from 98.88% in the rigid model to 98.83% in the moving lung model. It indicates that traditional rigid-wall assumptions overpredict particle accumulation in the distal airways. Furthermore, comparisons of rigid airway simulation results using 1-um particles with different carrier gases show that heliox (70% He and 30% O2) yields the highest overall DE to the peripheral lung downstream to G8 at 98.95%, followed by the 66.7% H2-33.3% O2 gas mixture, which produces a DE of 98.89%, slightly higher than standard air. These variations in deposition correlate directly with the interplay between the reduced mixture densities and their distinct viscosities, which fundamentally modify the Cunningham slip correction, fluidic drag, and particle relaxation times. These findings imply that using distinct carrier gases, such as heliox, not just for respiratory distress, but as an active engineering tool to push systemic drugs deeper into the acinar regions for optimal absorption. Our future work includes further investigation of particle size impacts (1, 5, 10 um) and breathing patterns (breathing rates = 12, 15, 20 times/minute) on distal airway deposition in the moving lung model.

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9HR.13

Impact of Sinonasal Anatomy and Intranasal Delivery Conditions on Target Site Deposition in Chronic Rhinosinusitis. DENNIS FRANK-ITO, *Duke University*

Introduction: Topical corticosteroids are routinely prescribed as monotherapy or adjunctive therapy for chronic rhinosinusitis (CRS), typically delivered via intranasal sprays devices. Optimizing spray delivery characteristics to target sinonasal regions remains challenging, particularly because intranasal deposition is influenced by intersubject and intrasubject anatomic variability.

Methods: Computational fluid dynamics modeling was used to evaluate delivery conditions that maximize deposition in the ostiomeatal complex (OMC) in an adult male patient with bilateral CRS before and after functional endoscopic sinus surgery (FESS). Computed tomography images obtained at three time points: initial diagnosis (PRE1), 31 months later (PRE2), and 46 months later (POST; 6 months after FESS); and were used to reconstruct patient-specific sinonasal airway models. Dug particle transport simulations (1–100µm) were performed at resting inspiration (15L/min) across five release locations (Bottom, Center, Top, Lateral, Medial), five head positions (Mygind, Supine, Tilted-Back, Tilted-Forward, Upright), and three spray velocities (1, 5, and 10m/s).

Results: In PRE1, maximum left OMC deposition was 7.06% with Tilted-Forward, Top, and 1 m/s, while maximum right OMC deposition was 7.44% with Tilted-Forward, Lateral, and 5 m/s. In PRE2, maximum left and right OMC deposition increased to 8.87% with Mygind, Top, and 10 m/s, and 19.84% with Supine, Center, and 10 m/s, respectively. In the POST model, maximum left OMC deposition was 6.47% with Upright, Top, and 1 m/s, whereas right OMC deposition reached 26.82% with Tilted-Back, Medial, and 1 m/s.

Conclusion: These findings show that optimal intranasal spray deposition into the OMC is highly sensitive to both patient-specific sinonasal anatomy and spray delivery conditions, which vary over time and after FESS.

9HR.14

Ambient PM2.5-Derived Water-Soluble Organic Mixtures Disrupt Albumin-Amyloid-β Binding Through Selective Molecular Interference. YALING ZENG, Xin Yang, *Southern University of Science and Technology*

Long-term exposure to fine particulate matter ($PM_{2.5}$) has been associated with increased risk of Alzheimer's disease, yet the molecular pathways linking ambient particulate mixtures to disrupted amyloid-β(Aβ) handling remain poorly defined. Here, we combined decade-long nontarget molecular profiling of ambient $PM_{2.5}$ with protein binding assays, contribution analysis, and molecular simulations to resolve how water-soluble organic molecules (WSOM) interact with human serum albumin (HSA), a major carrier involved in peripheral Aβ sequestration. Across all samples, 11,848 WSOM were detected, of which 8,034 were associated with HSA and 5,237 attenuated HSA-Aβ binding. Interference was highly uneven across molecules, with reduced nitrogen-containing species contributing disproportionately to the total effect. Docking and molecular dynamics simulations showed that interfering WSOM preferentially bind HSA domain II and weaken Aβ association through long-range allosteric modulation rather than direct competition at the Aβ-binding site. These results identify a chemically resolved pathway by which ambient $PM_{2.5}$-derived organic mixtures perturb protein function relevant to peripheral Aβ handling and highlight nitrogen-containing organics as potentially important drivers of pollution-associated molecular interference.

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9HR.15

Assessment of BTEX Pollution and Associated Health Risks from Crop Residue Burning in Agrarian Regions: Trends, Sources, and Ozone Formation Potential. BHUPENDRA SINGH, *Central University of Haryana, India*

Rapid urbanization and industrial growth can increase BTEX (benzene, toluene, ethylbenzene, xylenes) levels along with related health risks. This study compiles a five-year (2018–2022) dataset, collating and analyzing data on BTEX sources/emission routes, their temporal variation as well as non-carcinogenic/carcinogenic risk and ozone formation potential (OFP). Ambient BTEX monitoring data (2018–2022) were procured from the Central Pollution Control Board via trend analysis and diagnostic ratios (T/B, X/E, X/B, E/B). Hazard Quotient (HQ) was used for estimating health risks of non-carcinogenic effects, while Lifetime Cancer Risk (LCR) was considered for carcinogenic risk. Principal component analysis (PCA) and cluster analysis were used to investigate source-pattern and spatial grouping. Potential secondary pollution implications were inferred by estimating OFP. ∑BTEX average increased by 0.11 μg/m³ (2018) to 27.08 μg/m³ (2022). Diagnostic ratios in 2019–2022: T/B (2.39–4.79), X/E 1.17-1.41, X/B (0.79-1.05) and E/B (0.71-0.85); variable source contributions The Hazard Quotient (HQ) value were exceeded across 2019–2022 (1.14–2.04), whereas average lifetime cancer risk (LCR) was also high (2.67×10^{-4} to 4.79×10^{-4}). Furthermore, ozone formation potential (OFP) which increased dramatically from 5.09 in 2018 to 157.66 in 2021 with increase contribution of toluene (35% to 68%). BTEX correlations were strong (r=0.89–0.94). BTEX levels were substantially elevated with consistent carcinogenic and increasing non-carcinogenic risk as well as rising ambient OFP which highlights the necessity for emission regulations and public health programs in fast developing cities.

9HR.16

Lifespan Studies on Radionuclides in Beagle Dogs Conducted by the Lovelace Organization: 1960-2010. ROGER MCCLELLAN, *Independent Advisor, Toxicology and Risk Analysis*

Seaborg and associates at the U of C–Berkeley, in 1940 discovered a new element they named Plutonium (Pu). Pu–239 has a half-life of 24,390 years and was fissionable as was U–235. Both were selected to fuel fission bombs. The first atomic bomb, fueled with Pu–239, was detonated in NM on 7/16/45. Then, a U–235 bomb was detonated on 8/6/45 over Hiroshima, Japan, and a Pu –239 bomb detonated over Nagasaki, Japan, on 8/9/45 bringing an end to World War II, and triggering a Cold War. The US and Russia were soon producing Pu–239 and U–235 and detonating dozens of bombs, resulting in atmospheric dispersal of fission products. Nuclear reactors were also developed to produce electricity and propel naval vessels creating the need for scientific knowledge of health effects of radionuclides to set radiation protection standards. The first standards were based on epidemiological evidence from radium dial painters, uranium miners, and exposed patients.

In 1960 the Lovelace medical organization proposed to the US Atomic Energy Commission a program to construct facilities and conduct lifespan studies in NM with inhaled fusion product radionuclides. In 1966, McClellan assumed leadership of the program. A strategic plan was created using a "source – exposure – dose – response" paradigm. Studies were initiated in Beagle dogs exposed to Sr90, Y90, Cs137, and Ce144 soluble and insoluble aerosols. Later, studies were initiated with Pu–239 and Pu–238 oxide as monodispersed particles.

The acute health effects—as well as the later occurring carcinogenic effects—of the inhaled radionuclides were characterized. In 2010, data on Russian workers exposed to Pu–239 revealed an increase in lung and liver cancer that mirrored and validated the dog results. The results of the dog studies complemented the epidemiological findings and provide a firm basis for current Radiation Protection Standards.

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9HR.17

Metal Solubility, Speciation, and Oxidative Potential of Volcanic and Volcanically Influenced Aerosols from Mt Etna and Catania, Italy. MUSHTARI SAIDIKOVA, Alexander Zherebker, Giuseppe Salerno, Gaetano Giudice, Bizhou Zhou, Alexandra Turchyn, Anja Schmidt, Clive Oppenheimer, Chiara Giorio, *University of Cambridge*

Health effects from air pollution are often attributed to particulate-bound metals, but current assessments often rely on PM mass alone, or the total metal concentration. These approaches do not account for the fact that metals in aerosols may exist in multiple chemical forms, each with distinct solubility, reactivity, and bioavailability. We examined the speciation, solubility, and oxidative potential (OP) of volcanic aerosols from Mt Etna and volcanically influenced urban aerosols in Catania (Italy), at the foot of the volcano. Volcanic aerosols from Etna showed high soluble metal fractions and elevated concentrations of both known and potentially toxic metals near the source. Volcanically influenced aerosols from Catania showed lower metal abundance and generally reduced solubility, although solubility increased in some cases within the smallest size fraction. Thermodynamic speciation modelling predicted that these metals were present not only as free ions but also as inorganic hydrolytic species and oxalate complexes. Aerosol pH was the primary factor controlling metal speciation in our samples, with changes in acidity leading to shifts among dissolved, inorganic, organic, and precipitated forms. To explore the health effects of volcanic and volcanically influenced aerosols, we measured their OP. Volcanic aerosols showed higher OP responses than those from Catania, with thiol antioxidants showing the greatest depletion. OP of Catania aerosols varied according to size fraction, with ascorbic acid depletion more pronounced in the ultrafine fraction and thiol antioxidant of glutathione depletion more pronounced in the coarse fraction. For both volcanic and volcanically influenced aerosols, OP was strongly associated with bulk soluble concentrations and Fe and Cu speciation. Our results show that bulk metal concentrations and size alone are insufficient to assess potential health effects, and that metal speciation must also be considered.

9HR.18

PAH Content Redirects the Type of Pulmonary Immune Response to Inhaled Carbonaceous Particles. KYUHONG LEE, *Korea Institute of Toxicology*

Airborne PM2.5 differs in chemical makeup from place to place, yet inhalation risk is still judged mostly by mass. We tested whether the polycyclic aromatic hydrocarbon (PAH) content of a particle changes the kind of lung immune response, not just its magnitude. We compared two carbonaceous particles of similar diameter, surface charge, and FT-IR spectrum whose total PAH content differed about 52-fold: a high-PAH artificial black carbon (KPM) and a low-PAH diesel exhaust particle (DEP). Mice received each particle by nose-only inhalation (MMAD 0.49 µm, GSD 1.53, 15.4 mg/m3) and by intratracheal instillation. We measured bronchoalveolar lavage cell counts, lung histopathology, and 3-prime mRNA expression.

The two particles produced different kinds of response, not different intensities of the same one. KPM recruited eosinophils and lymphocytes and shifted the transcriptome toward a type 2 program. DEP produced a macrophage-dominant, granulomatous response with an innate, neutrophilic signature. The KPM type 2 response lacked the classical T helper 2 effector cytokines; we therefore read it as a non-canonical type 2 reaction rather than ordinary allergic inflammation.

Particle composition can set the direction of the lung immune response, not only scale it. For combustion-derived PM2.5, PAH content deserves weight in inhalation hazard assessment alongside mass.

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9HR.19

Simulated Stakeholders, Cross-Team Expert Cohorts, and Productive Integration Conflict: A Replicable Design for a Semester-Long Air Quality Engineering Group Project.

SHANNON CAPPS, *Drexel University*

Group design projects in air pollution control courses often collapse into a partitioned report in which students divide the work, staple the pieces together, and never confront the disciplinary friction or political constraint that defines professional practice. This poster documents the design and implementation of a nine-week group project built for a combined undergraduate/graduate Air Quality Engineering course (ChBE 3890/5890) at Vanderbilt University in Spring 2026, presented as a blueprint instructors can adapt.

Four design decisions distinguish it. First, problems are student-generated rather than instructor-supplied: a sensor-equipped photographic scavenger hunt requires each student to document ten original encounters with air pollution, and those observations become the candidate problems from which teams select a real, documented case for instructor approval. Second, teams author three constrained AI stakeholder personas — a high-power institutional actor, an economic/operational actor, and an affected community actor — specifying identity, incentives, constraints, decision authority, blind spots, and behavioral rules, then stress-test their own technical decisions against at least two personas and document how pushback did or did not change their approach. AI serves as a constrained decision agent rather than an answer engine, and critical reflection on where the simulation fails is explicitly rewarded. Third, teammates hold complementary specialist roles (Emissions and Control Strategy Design; Transport and Chemistry; Benefit Assessment), but each individual technical deliverable is developed within a cross-team cohort of same-role peers analyzing different cities, deliberately isolated from teammates. Fourth, because isolation guarantees conflicting assumptions, every report must supply explicit linking points — inputs needed, outputs provided, assumptions to reconcile — converting those conflicts into the substance of team integration. Work culminates in a multi-audience professional website, replacing the traditional poster, evaluated by a peer-review matrix guaranteeing each section both specialist and non-specialist critique.

Reflection, peer-review, and rubric assessment data will be presented.

9IM.1

Bidimensional Charge Distribution of Spherical and Aggregate Nanoparticles in a Unipolar Diffusion Charger.

NISHAN SAPKOTA, Rym Mehri, Joel Corbin, Steven Rogak, Timothy Sipkens, *University of British Columbia*

Unipolar charging is widely used for particle sizing, capture, and detection. Within these applications, one requires prior knowledge of charge distribution for reliable data inversion and improved instrument design. Here, we use tandem differential mobility analyzers to measure not only the average charge on the particles but the entire bidimensional charge distribution. Doing so requires data inversion techniques that can resolve the narrowing electrical mobility for adjacent charge states as the particle size increases. We perform this inversion for only the second time, and using an entirely new inversion approach using a modified exponential distance prior. This significantly improves reconstruction accuracy, which is demonstrated using simulated data. The method is validated using experimental data from a diffusion-based unipolar charger operated at two ion concentration-time product (Nit) of $5x10^{12}$ and $3x10^{13}$ ion.s/m^3. We analyze particles of two different shapes: spheres (Santovac, a commercial polyphenyl ether) and fractal aggregates (soot from an inverted burner). These particles are initially conditioned (e.g., dried and/or diluted), size-selected using an Aerodynamic Aerosol Classifier (AAC) and a differential mobility analyzer (DMA) in tandem, and then passed through the unipolar charger for final characterization using a second DMA column. The AAC eliminates multiply charged particles passing through the first DMA and ensures that the particles have a known mobility diameter before being recharged, completely avoiding reliance on charge correction algorithms. The results show that the aggregates acquire much higher charge than spheres for a given size, while the charge distribution width remains the same. This finding significantly simplifies discerning the shape effects for any charge measurement going forward, as it becomes only an average charge effect. Finally, this morphology-driven difference between a sphere and an aggregate is expressed in terms of charging equivalent diameter, making the results independent of charger design and transferable to other instruments employing charge conditioning.

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9IM.2

First Results from the AFN Measurements During the VENUSIAN Mission. DARREL BAUMGARDNER, Christopher Carr, Ted Fisher, Snigdha Nellutla, *ENVEA, Boulder, Colorado*

The Autofluorescence Nephelometer (AFN), that will be measuring Venus cloud droplets in 2027, was installed on an uncrewed airborne vehicle (UAV) and flown through layers of haze produced by the Hawaiian volcano, Kilauea in March 2025. This project, supported by the NASA Planetary Science and Technology from Analog Research (PSTAR) program, was designed to exercise the measurement capabilities of the AFN, prior to the Venus mission. In particular, the AFN measures the polarized light scattering and fluorescence from individual particles in the approximate equivalent optical diameter (EOD) range from 2 – 20 µm. From these measurements the number concentrations can be derived and the refractive index (RI) extracted. Additional shape information is also obtained from the polarization ratios.

Preliminary results from one of the flights will be discussed. During these flights, the haze layer was sampled over an altitude range from 750 to 1500 m for more than an hour. The aerosol particles were mostly less than 5 µm in EOD, with an average mode slightly less than 3 µm. The total number concentrations varied between 2 – 20 cm-3 and more than 90% of the particles were fluorescing when illuminated with the AFN's 440 nm laser. The polarization ratios indicate that the majority of these particles had a RI of around 1.38, similar to the RI of 40-50 weight percent sulfuric acid.

This presentation will briefly describe the AFN's measurement principles with a more detailed discussion of how particle size, shape and RI is extracted from these measurements.

9IM.3

From OC/EC Equivalence to Real-Time Carbonaceous Aerosol Speciation: Performance of the New TCA09 Analyzer in a One-Year ASCENT Field Campaign in Atlanta, Georgia. MARTIN RIGLER, Matic Ivančič, Sohyeon Jeon, Ruizhe Liu, Gašper Lavrič, Bálint Alföldy, Irena Ježek Brecelj, Varun Yadav, Nga Lee Ng, Asta Gregorič, *Aerosol d.o.o.*

Carbonaceous aerosols are a major fraction of PM2.5, influencing air quality, public health, and Earth's radiative balance. While thermal-optical OC/EC remains the reference for carbonaceous aerosol measurements, there is a growing need for standards-oriented, online approaches that provide high time resolution and operational robustness for long-term monitoring. Here we present the new instrument, Total Carbon Analyzer TCA09, and its integration into the Carbonaceous Aerosol Speciation System (CASS; Aerosol Magee Scientific), combining a TCA instrument with an Aethalometer (AE36s, AE36 or AE33) to enable concurrent, real-time measurements of total carbon (TC) and black carbon (BC), with organic carbon (OC) derived by difference (OC = TC – BC) [1].

TCA09 introduces several advances targeting equivalency and field operability, including (i) compliance with offline OC/EC carbon calibration practices, (ii) an automated "zero check" concept aligned with CEN/TR 18076:2024, European Technical report for online equivalent methods, and (iii) an expanded application range through shorter measurement time bases (10 minutes), enabling improved resolution of transient events. Additional improvements include simplified installation and automated verification procedures, extended filter lifetime, enhanced safety and robustness, reduced size and weight and a redesigned graphical user interface.

CASS with TCA09 prototype was deployed for more than one year at the ASCENT monitoring site in Atlanta, Georgia, providing a continuous, high-time-resolution dataset of TC, BC, and derived OC, which we compared to the concurrent offline 24h OC/EC filter measurements. We further demonstrate post-processing capabilities for real-time OC speciation using the BC tracer framework, including extensions that separate liquid-fuel and solid-fuel contributions (BCLF, BCSF) and estimate primary OC from both sources (POC_{LF}, POC_{SF}), and secondary OC (SOC) via a 2D minimum R^2 (MRS) optimization [3]. The results illustrate how CASS supports long-term monitoring with improved operational stability while delivering actionable, time-resolved TC (OC/BC) for source apportionment and atmospheric process studies.

[1] CEN/TR 18076:2024, Ambient air – Equivalence of automatic measurements of EC and OC in PM. CEN, 2024.
[2] Rigler et al., Atmos. Meas. Techn., 2020.
[3] Ivančič et al., Sci. Total Environ., 2022.

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9IM.6

Physics-Guided Electrospray Generation of Monodisperse Aerosols for Particle Counter Calibration. YEHYA AUSSI, *Southwest Research Institute*

Accurate calibration of particle counting instruments requires stable, repeatable aerosol sources with controllable size and concentration; however, the conventional approach to generating calibration aerosol often exhibit variability in output or limited tunability across size ranges. This work presents a physics-guided framework for generating monodisperse aerosols using an electrospray platform (TSI EAG 3480 – Emory Oil) as a reliable source for particle counter calibration. The approach combines capillary-driven flow prediction with electrospray scaling relationships to control droplet formation and resulting particle size. Particle diameter is modeled as a function of liquid flow rate, electrical conductivity, and nonvolatile fraction, while spray current is predicted using cone-jet scaling proportional to $(KQ)^{1/2}$ to ensure operation within a stable regime. A drying model incorporating gas flow, residence time, and evaporation kinetics is introduced to quantify a dimensionless dryness ratio, enabling identification of conditions that produce fully dried, size-stable particles. A computational tool was developed to perform basic prediction modeling, allowing users to specify a target particle size and obtain corresponding formulation and general operating parameters. Results demonstrate repeatable particle size distribution generation with predictable scaling across operating conditions. The framework provides a robust method for producing a stable aerosol source suitable for the calibration of particle counting instrumentation.

9IM.7

Resolving Size Discrepancies in Sub-40nm Nanoparticles Using ES-SMPS, DLS, and Deep Learning Assisted TEM. ALEXANDER MENK, Christopher Bonino, *Particle Measuring Systems*

Accurate characterization of sub-40-nm nanoparticle standards is critical for aerosol measurements, particularly for mobility diameter calibration and number concentration accuracy. In this study, we characterize polystyrene latex (PSL) and silica nanoparticle standards using three complementary techniques: Electrospray Scanning Mobility Particle Sizer (ES-SMPS), Dynamic Light Scattering (DLS), and Transmission Electron Microscopy (TEM), which probe mobility, hydrodynamic, and geometric diameters, respectively.

TEM images are analyzed using a supervised deep-learning segmentation workflow trained on annotated datasets, enabling automated particle identification and sizing. This approach increases sample size while reducing analysis time and operator bias compared to manual methods. The resulting size distributions are compared to measurements obtained from ES-SMPS and DLS.

Ultrafiltration is evaluated as a sample preparation step to remove surfactants and dissolved contaminants. We discuss the effectiveness of different filtration media on the reduction of non-volatile residue and nanoparticle distributions, characterized by ES-SMPS.

These results highlight systematic differences in reported particle sizes arising from technique-specific measurement principles. This work demonstrates the necessity of at least two complementary methods for robust characterization of sub 40 nm nanoparticle standards and provides practical insight into improving accuracy in aerosol measurements.

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9IM.8

Development of a Compact, High-Performance, Multi-Pass Photoacoustic Aerosol Absorption Spectrometer (PAS) Capable of Measurements from Blue to Infrared Wavelengths. MAX APPELBAUM, Matthew Burkhart, Owen Cruikshank, Anna Robertson, Kaitlin Schulist, Bryan Rainwater, Brian Annis, Clint Middlemist, Braden Stump, Shane Murphy, *University of Wyoming*

We present laboratory results for a novel multi-pass photoacoustic absorption spectrometer (PAS) built upon the highly successful cell design first introduced by Lack and coworkers in 2009. While various derivatives of the Lack PAS design, including our own instrument, have yielded high signal to noise measurements on a variety of stationary and mobile platforms, they all suffer from being relatively heavy and power hungry. We will present details of our novel design that allows for transmission of IR to visible wavelengths into a single multi-pass photoacoustic cell. The unique instrument design and calibration approach allows for us to rapidly transition between wavelengths and for all wavelengths to have sufficient optical power to achieve high signal to noise. We observe signal to noise ratios comparable to current multi-pass instruments that have a single wavelength per cell. We demonstrate how this approach allows us to significantly reduce size, weight and power requirements yielding an instrument that is person-portable. Finally, we will discuss potential applications for this new instrument.

9IM.9

Novel Optical Instruments for Size-Resolved Aerosol and Cloud Particle Measurement. MATTHEW FREER, Matthew Berg, Benjamin Swanson, *CloudSci*

Aerosol measurement increasingly demands instruments that combine wide size coverage, compositional sensitivity, and practical deployability across field settings. CloudSci is developing a set of optical sensors designed to provide size-resolved, composition-sensitive data across the full aerosol–cloud particle size range. This poster introduces three instruments under development.

The Passive Aerosol Imager (PAI) combines digital in-line holography with a triggered open-path sensing system to record scattering patterns of ambient particles from ~4 µm to 200 µm. In addition to size and concentration, PAI retrieves high-resolution particle images, enabling shape-based classification. A machine-vision pipeline converts raw holograms into size, aspect-ratio, and spatial distributions in less than 1 second per frame, allowing continuous coarse-mode monitoring without sampling artifacts. Applications include coarse-mode aerosol research, pollen detection, and fog measurement.

The Aerosol Multi-Angle Sizing Spectrometer (A-MASS) is an airborne aerosol sizing probe (0.1–5 µm) engineered to fit standard PMS canisters, making it a drop-in upgrade for existing research aircraft. The instrument measures particle size distributions and concentration with configurable size bins, with an option to capture high-resolution per-particle waveforms. We present initial sizing and concentration results for laboratory-generated aerosols and outline plans for field testing.

The Open-Path Holographic Ice Imager (OPHII) is an open-path holographic spectrometer designed to characterize small ice particles in clouds and aircraft contrails, including sizes into the submicron range. Now entering NASA-sponsored Phase II development toward a flight-ready instrument, OPHII targets the earliest stages of ice formation and growth—observations relevant to understanding contrail climate impacts and high-altitude cloud processes.

The poster will present datasets from laboratory and field deployments, performance comparisons with existing instruments, and uncertainty analysis. Expected applications span airborne aerosol research, coarse-mode characterization, pollen monitoring, and cloud microphysics. Together, these instruments aim to reduce practical barriers while broadening what can be measured with in-situ aerosol and cloud observations.

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9IM.10

Seamless 1–1000 Nm Size Distributions of Fine Particles by Combining PSM 2.0 and SMPS. AKI PAJUNOJA, Joonas Vanhanen, Dagen Hughes, Jyri Mikkilä, *ENVEA*

Accurate measurement of ultrafine particle (UFP) size distributions across the 1–1000 nm range remains challenging in aerosol science. No single instrument covers this span with sufficient sensitivity, particularly in the sub-3 nm regime critical for new particle formation and early growth. We present a system combining a Particle Size Magnifier (PSM 2.0, 1–12 nm) with an Scanning Mobility Particle Sizer (SMPS, 10–1000 nm), enabling continuous size distribution measurements from 1 nm to 1 µm.

The PSM 2.0 extends detection to 1 nm using diethylene glycol–based activation, with size distributions derived from controlled supersaturation scanning and inversion [1]. The SMPS measures size distributions via electrical mobility classification and condensation particle counting in the 10–1000 nm range.

Although both instruments report electrical mobility diameter, their principles differ fundamentally: the SMPS performs electrical mobility selection, whereas the PSM relies on size-dependent activation probability calibrated to electrical mobility standards. Merging the datasets therefore requires harmonization in the overlapping 10–12 nm region, alignment of transfer functions, charging propabilities, consistent inversion, and corrections for diffusional losses. Laboratory and ambient measurements are presented to quantify performance in the overlap region and assess continuity of the merged spectrum across 1–1000 nm. The results illustrate how activation-based and mobility-based sizing can be integrated into a unified size distribution while identifying remaining uncertainties at their interface.

For practical deployment, both instruments are operated within a unified software environment enabling synchronized scanning, centralized acquisition, and automated generation of a combined full-range size distribution. This workflow reduces post-processing complexity and supports standardized operation, making the system suitable for ACTRIS infrastructures, air quality research, emission characterization, and fundamental aerosol studies.

9IM.11

Sensitivity of Photoacoustic and Photothermal Spectroscopy for Probing Properties Besides Absorption - Influence of Excitation Frequency in Single Particle Studies. FELIX STOLLBERGER, Alexander Bergmann, *Graz University of Technology*

Photoacoustic and photothermal spectroscopy are highly sensitive indirect absorption spectroscopy techniques, commonly used to probe gas or aerosol concentrations via absorption measurements. Both techniques rely on a periodic excitation of a sample with a modulated light source and detect the amplitude and phase of the sample's temperature oscillation (ΔT_p) acoustically or optically. Besides their broad applications in ensemble measurements, they proved to be also useful for studying transfer processes and accommodation coefficients on a single particle level when combined with optical levitation.

The complex valued ΔT_p is not only influenced by the particle absorption cross-section, but also by properties such as particle density, heat capacity or interfacial thermal conductivity. Furthermore, the excitation frequency (ω) determines the time scales under which those properties are measured. So far, ω is typically tuned to optimize the SNR of the photothermal or photoacoustic amplitude, given that the sensitivity of ΔT_p with respect to sample absorption is frequency independent. This assumption no longer holds if other properties besides absorption are of interest.

In this study, we systematically investigate the frequency dependent sensitivity of ΔT_p with respect to other properties besides sample absorption. First results show that measurements at low modulation frequencies (several Hz) are useful for probing heat transfer processes, whereas measurements at high frequencies (several kHz) are more sensitive towards changes in the thermophysical properties of the particle.

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9IM.12

Examining the Concentration-Dependent Counting Efficiency of the Community Condensation Particle Counter (cCPC).
ABHAY VIDWANS, David Hagan, *QuantAQ, Inc.*

Ultrafine Particles (UFPs), defined as particles with an aerodynamic diameter less than 100 nm, present significant hazards to human health due to their uniquely small size and high surface-volume ratio. Despite this threat, UFP concentration levels are not widely regulated due to the lack of affordable and field-deployable instruments capable of performing such measurements. To address this issue, Aerosol Dynamics (Berkeley, CA) developed a highly compact and lower-cost UFP instrument: the Community CPC (cCPC). This novel water-based CPC utilizes adiabatic expansion to grow and detect particles down to 4nm. In the seminal study (Hering et al., 2025), the cCPC's measured UFP concentration is shown to be closely correlated to that of a 2nm CPC. In laboratory evaluation, the slope of this correlation (i.e., counting efficiency) linearly decreased with increasing concentration, up to approximately 100,000 cm-3. In ambient environments, however, no degradation in counting efficiency was observed, even when exposed to UFP concentrations significantly higher than this limit. The discrepancy between laboratory and ambient cCPC behavior may be explained by the differences in the aerosols being measured. In this study, we rigorously test this hypothesis through a set of experiments and theoretical models aimed at understanding the cCPC's response to different types of aerosols.

9IM.13

In Situ Single Particle Measurements of Submicron Aerosol Particle Phase State.
VINCENT KIPTER, Angel Gibbons, Paul Ohno, *Auburn University*

Aerosols are inherently heterogeneous, with particle-to-particle variability in composition and physical properties influencing their environmental and health impacts. Consequently, a comprehensive understanding of aerosol physicochemical properties requires characterization at the single-particle level. In situ measurements of the phase state of individual particles remains experimentally challenging due to their small sizes. Fluorescence-based techniques employing environmentally sensitive probes, such as excited-state intramolecular proton transfer (ESIPT) fluorophores, have recently emerged as promising tools for probing aerosol microenvironments. Here, we present the development of an in situ single-particle aerosol fluorescence technique based on the ESIPT probe 2-(2-benzofuranyl)-3-hydroxychromone (3-HC) that enables direct, non-destructive, particle-resolved measurements of the phase state of submicron particles for mixed organic and inorganic systems. In this approach, 3-HC is volatilized and incorporated into atomized PEG and NaCl aerosol particles, and the change in water content and local polarity associated with phase transitions is detected in the fluorophore response. Finally, possible future applications of this approach to access to aerosol phase state and mixing state in more complex aerosol systems is discussed.

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9IM.14

Constraining Vertical Cloud Condensation Nuclei Concentrations Using Single-Particle Chemical Composition During the TRACER Campaign. JING LI, Nurun Nahar Lata, Zezhen Cheng, Ashfiqur Rahman, Sining Niu, Darielle Dexheimer, Matthew A. Marcus, Fan Mei, Allison Steiner, Jian Wang, Swarup China, *Pacific Northwest National Laboratory*

The assumption of a well-mixed boundary layer is frequently employed in Aerosol-Cloud Interaction (ACI) modeling, yet it limits the accurate prediction of Cloud Condensation Nuclei (CCN) in environments influenced by diverse emission sources and with strong atmospheric stratification. High-resolution vertical CCN profiling remains limited by aircraft operational cost and the payload restriction of Tethered Balloon System (TBS) and Uncrewed Aircraft System (UAS). In this study, we overcome these limitations by integrating offline analysis of single-particle chemical composition with in-situ particle size distribution and total number concentration measurements from TBS sampling to estimate aloft CCN profiles during the TRACER campaign in Houston, Texas. To confirm the feasibility of our approach, a ground-based closure study is first conducted, demonstrating that integrating single-particle chemical composition and morphology into the κ-Köhler framework yields CCN concentrations within a 30% uncertainty range from supersaturation (*SS*) 0.13% to 0.47%. Applying this validated framework to aloft measurements, we identified a critical regime shift governing CCN activation: at *SS* below 0.3%, vertical variability of CCN concentration is primarily driven by aerosol chemical composition. At *SS* above 0.3%, the vertical differences are increasingly governed by particle size distribution and total number concentration, with chemical composition playing a secondary role. The elemental chemical composition is used to classify 9 particle types, including biological, dust, dust mixed with carbonaceous, dust mixed with sulfate, sea salt, sea salt mixed with sulfate, carbonaceous, sulfate, and other particles. The particle types differ between ground and aloft layers. The majority of ground samples exhibit higher fractions of dust particles with fractions from 4% to 33%, whereas the majority aloft samples enriched in carbonaceous particles with fractions from 53 % to 87 %, which shows atmospheric stratification can trap distinct aerosol populations in elevated layers that ground-based instruments fail to detect. This study underscores the limitations of the well-mixed boundary layer assumption and suggests that single-particle techniques can serve as a complementary approach for estimating vertical CCN profiles, particularly in settings where direct CCN measurements are not feasible.

9IM.15

A Comparative Study on GC-MS and GCxGC-MS of Maritime Port Collected Samples. JOSHUA SCHEEL, Thomas Eckel, David R. Cocker, Kyah Gracia, *University of California, Riverside*

Portside communities face unique air quality challenges when referenced against their more inland counterparts due to their proximity to maritime logistic centers. The combustion of higher molecular weight fuel mixtures can convolute expected end products, leading to problematic emissions such as PAHs (Polycyclic Aromatic Hydrocarbons) and Furans. While PAHs have widely been recognized as problematic in the context of human health, similarities in volatility or polarity lead to significant convolution through chromatographic separations.

Though an effective metric for most regulatory purposes, more complete speciation of emissions grants greater insight into health effects that may arise in local communities while also elucidating pathways to reduction of harmful end products. Similarly, Furans find themselves as a chemical family of interest for both health and environmental concerns. The capture and subsequent processing of this chemical group proves challenges in gas chromatography due to its volatility.

Cryogen modulated GCxGC-ToFMS analysis not only enables the effective concentration and separation of compounds such as Furans, but also the elucidation of co-elutions that one dimensional chromatography struggles to attain. This research highlights the insights granted by the use of two-dimensional chromatography as compared to identical samples separated and quantified in traditional GC-MS analysis. All of this information benefits portside communities and other forms of research such as source attribution. Profiling of constituent engine emissions enables the ‘fingerprinting’ of ocean going vessels, and greater understanding of their contribution to emissions inventories.

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9IM.16

A Redesigned Variable-Orifice Inlet for Constant-Pressure Stratospheric Aerosol Sampling Aboard the NASA WB-57.

TEGAN BROWN, Samuel Taylor, Ming Lyu, Charles Brock, Daniel Murphy, *CIRES/NOAA Chemical Sciences Laboratory*

We present a redesigned variable-orifice inlet (VOI) for constant-pressure atmospheric sampling. Here, the VOI supports the NOAA Aerosol Microphysical Properties (AMP) suite's Next-Generation Nucleation Mode Aerosol Size Spectrometer (NMASS-ng), which measures 3–60 nm aerosol size distributions across ambient pressures from 1000 hPa to below 70 hPa in the stratosphere aboard the NASA WB-57. The NMASS requires active pressure control to maintain a stable internal pressure and high particle transmission efficiency across all WB-57 flight altitudes. Based on the O-ring pinch design of Molleker et al. (2020), the VOI uses a compressed O-ring to regulate downstream inlet pressure. Design requirements included repeatable orifice geometry and minimal material degradation across the full compression range, rapid response to changing ambient pressure, reliable actuator authority at low stratospheric pressures, and minimal particle losses. The VOI concept was demonstrated successfully in flight during the 2023 and 2025 SABRE campaigns, with intermittent reliability issues at high elevations informing the current redesign. Bench testing demonstrates that the redesigned VOI quickly adjusts to changing pressure setpoints while maintaining stable internal pressure control across the full operating range. Future integration with the Particle Analysis by Laser Ablation Mass Spectrometer instrument (PALMS) and a tropospheric NO_2 instrument is also planned, extending the VOI approach to additional platforms. We will present results from ground-based transmission-efficiency comparisons with the Ultra-High Sensitivity Aerosol Size Spectrometer (UHSAS) and in-flight validation from the 2026 SABRE campaign.

9IM.17

Low-Cost Sensor Measurement Dependency on Wind-Speed and Sensor Orientation.

SREEKESH KOOKKAL, Haripriya Mahapatra, Suresh Dhaniyala, *Clarkson University*

Ambient monitoring of PM with regulatory quality instruments are made with well-characterized inlets that ensure minimal dependence on wind-speed and orientation. The deployment of low-cost sensors for ambient measurements, however, have been barely guided with any specifications about their sampling systems or installation layout. Considering that the low-cost sensor measurements are seen to have different calibrations at different locations, it is critical to understand the specific contribution of wind speed and wind orientation to sensor measurements. In this study, we evaluate the performance of the PMS5003 and SPS30 sensors as a function of wind speed and wind direction. We conducted wind-tunnel studies at wind-speeds ranging from 0.5 to 5 m/s with the sensors in five different orientations relative to the flow direction. The measurements show that the relative concentrations reported by the sensors under these test conditions vary with wind conditions with some directions much more sensitive to windspeed than others. Additionally, we compared the ambient performance of the sensors placed in a passive enclosure (like Purple Air's) vs when placed in an actively sampling enclosure. The results of these sensor evaluation studies will be presented at the conference.

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9IM.18

A Thermal Evolution-Based OC-EC-IN-ON Analyzer for Simultaneous Determination of Organic Carbon, Elemental Carbon, Inorganic Nitrogen, and Organic Nitrogen in Aerosols. JIANZHEN YU, Cong Cao, Yee Ka Wong, *Hong Kong University of Science & Technology*

Carbonaceous and nitrogen-containing species are major components of atmospheric aerosols. Accurate measurement of these components is essential for quantifying aerosol impacts on air quality, climate, ecosystems, and human health. Here we present the first instrumental approach that simultaneously quantifies organic carbon (OC), elemental carbon (EC), inorganic nitrogen (IN), and organic nitrogen (ON) in aerosol samples. The method couples thermal evolution (TE) with multivariate curve resolution (MCR) to separate overlapping TE signals from OC, EC, IN, and ON—overcoming a key limitation of conventional thermal methods that do not incorporate MCR-based deconvolution. Validation against established reference methods showed strong agreement for all four components. Compared with OC and IN, EC and ON exhibited larger relative uncertainty, consistent with their typically lower contributions to total carbon and total nitrogen and with unavoidable ambiguities in MCR deconvolution. We applied the method to hundreds of aerosol samples collected at multiple sites in China. In addition to mass concentrations of IN, ON, OC, and EC, atomic OC/ON ratio was also obtained. This ratio, largely inaccessible in prior aerosol characterization studies, offers a new constraint for evaluating contributions from biogenic and anthropogenic sources and for improving atmospheric model representation of carbonaceous and nitrogenous aerosol sources and transformations. Overall, the capability to quantify OC, EC, IN, and ON simultaneously represents a significant advance in aerosol chemical characterization.

9IM.19

Wind Tunnel and Numerical Investigation of a Nested Inlet for Stratospheric Aerosol Sampling. NAGARAJAN RADHAKRISHNAN, Charles Brock, Suresh Dhaniyala, *Clarkson University*

Stratospheric aerosol particles critically influence Earth's radiation budget and climate. Accurate characterization of these particles requires aircraft-based measurements with research-grade instruments, yet high-speed, high-altitude sampling presents persistent challenges due to flow compressibility, turbulence, and atmospheric variability.

The Nested Inlet for Sampling Stratospheric Aerosol (NISSA) was designed to mitigate turbulence effects and enhance representative aerosol sampling across a broad particle size range (10 nm to 10 µm). NISSA features a nested two-stage inlet design with a primary inlet that reduces flow velocity and turbulence intensity, coupled with a secondary inlet that samples particles under characterized flow conditions. The inlet was successfully deployed on NASA's WB-57 aircraft and flown during the SABRE 2025 test campaign, which included seven high-altitude research flights.

Flight characterization of the flow field in the inlet was made using pressure and high-frequency hot-wire anemometer measurements at several locations within the inlet. Initial analysis of the flight data suggests that the CFD simulations reasonably predicted average velocities in the inlet but only qualitatively predicted trends in turbulence characteristics in the inlet flow as a function of operating conditions. To understand the reasons for the discrepancy in turbulence characterization between flight data and CFD simulations, we conducted a series of wind tunnel studies, where we systematically varied the different inlet features to identify the reasons for the discrepancy. In this presentation, we will highlight the findings of the wind tunnel analysis with a particular focus on the characterization of turbulence intensities and their impact on particle transport. The results of this study will critically inform turbulent modeling of inlet flows for aircraft sampling, an important element for accurate assessment of atmospheric composition.

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9IM.20

Aerosol Phase Transition Detection Through Temperature-Controlled Bipolar Charging and Ion Attachment Analysis.

SANGHEE HAN, Sunandan Mahant, Markus Petters, *University of California, Riverside*

The phase state of atmospheric aerosol particles, determined by their deliquescence and efflorescence, controls their reactive uptake and size distribution. One common challenge of observation methods for phase transition is the relative humidity control along the entire measurement trajectory. In this study, a new method is presented to measure the aerosol phase transition with temperature controlled aerosol charging conditions. Particles are size-selected using the differential mobility analyzer (DMA) first, then the sample is passed through a temperature-controlled ^{210}Po charge conditioner. Relative humidity (RH) is controlled by adjusting temperature and inferred from independent measurements of the dew point temperature. The charged-conditioned aerosol size distributions were then measured by a second DMA, allowing the characterization of particle charge distribution before and after the deliquescence RH (DRH) and efflorescence RH (ERH) phase transition. Larger fractions of charge particles were observed upon deliquescence, mostly due to particle hygroscopic growth resulting from the phase transition. DRH was evaluated as a function of dry diameter between 15 and 80 nm. As a byproduct of the experiment, the measurements characterized bipolar charge fractions as a function of temperature for effloresced particles, which showed a decrease in the fraction of charged particles with a decrease in temperature. The observed bipolar charge fractions were compared against theoretical predictions from ion-particle attachment coefficients as a function of size, temperature and aerosol water content, thus providing new constraints to aerosol charging theory. The proposed measurements technique can be used to characterize the phase state of aerosol using laboratory and ambient measurements.

9IM.21

A Stabilization Approach for SML Characterization Providing Insights Into Marine-Atmosphere Microbial Connectivity.

OR ARGAMAN MEIROVICH, Ariel C. Tastassa, Jonathan Blaustein, Yael Dubowski, Naama Lang-Yona, *Technion - Israel Institute of Technology*

The Sea Surface Microlayer (SML) is a critical interface mediating the flux of gases, particles, and microorganisms between the ocean and the atmosphere. Despite its role as the primary source for marine primary organic aerosols (POA) and bioaerosols, direct in-situ sampling in the open sea remains technically challenging due to physical disturbances and the inherent fragility of the SML. This study presents the development and validation of a controlled biological sub-sampling methodology designed to stabilize SML characterization for subsequent aerosol-exchange analysis. To address these limitations, we developed and validated a dedicated biological sub-sampling methodology designed to facilitate SML collection and analysis in a controlled environment. To identify the optimal SML reformation window, 24-hour incubation experiments and 16S rRNA gene quantification and identification analyses were conducted on field and nutrient-enriched marine water. Results indicate that while the SML remains compositionally instable during the first two hours post-collection, a consistent steady state in bacterial abundance and composition was achieved between 3 and 6 hours. The methodology was validated against in situ sampling in the Mediterranean Sea and applied across a Pacific Ocean latitude gradient. Genomic data positioned the SML as a transitional mediator between the ocean and air, while 16S rRNA transcript analysis showed tight clustering between SML and atmospheric communities, suggesting selective environmental filtering of metabolically-active microbial communities. This stabilization approach provides a robust and standardized alternative to traditional sampling, particularly in rough sea conditions. By enabling reliable biological characterization of the SML, this research enhances our understanding of the mechanisms controlling marine-atmosphere microbial exchange and their impact on global ecological networks and atmospheric processes.

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9IM.22

Feasibility of Raman Analysis for 3D Printer Nano- and Microplastic Aerosols Emissions. SLATER PAYNE, Justin Morrow, Alyssa Yerkeson, Jun Wang, *University of Cincinnati*

Airborne nano- and microplastic (NMP) aerosols pose a significant environmental, occupational, and public health risk due to their prevalence and persistence. This feasibility study investigated a Raman spectroscopy method for qualitative and preliminary quantitative analysis of airborne NMP based on methods developed by the National Institute for Occupational Safety and Health (NIOSH) for respirable crystalline silica quantification. NMP aerosols were generated using a 3D printer with acrylonitrile butadiene styrene (ABS), polyethylene terephthalate glycol (PETG), and poly lactic acid (PLA) filaments at temperature ranges from 230°C to 260°C, collected on silver membrane air sampling filters, and analyzed directly on the filter using Raman spectroscopy. Spectral signatures for different polymer types were distinct, with notable chemical differences between the original filament and aerosolized particles, like unexpected polyethylene peaks. There were also distinct differences between the same polymer type sourced from different companies and from the same company after changes to their polymer's formulation. A preliminary calibration curves using PETG filaments sourced from two different brands also demonstrated a strong linear relationship with aerosol concentration (brand 1 $R^2 = 0.7638$ and brand 2 $R^2 = 0.9153$). These experiments demonstrated that Raman is a viable method for quantitative analysis of NMP aerosols. While this feasibility study demonstrates promise, further calibration development is needed before quantitative analysis of NMP aerosols exposure can be reliably achieved using Raman spectroscopy.

9NP.1

A Stochastic Comparative Analysis of Aerosol Synthesis and Co-Precipitation for High-Nickel Cathode Materials: R&D Targets and Scaling Pathways. OMAR ALLAHHAM, Adam Boies, *Stanford University ANEE Lab*

Lithium nickel-manganese-cobalt oxides, especially Ni-rich NMC811, are leading high-energy-density cathode materials for lithium-ion batteries. Conventional NMC production relies on co-precipitation of mixed transition-metal precursors followed by lithiation and high-temperature calcination, a multi-step route with substantial energy and water demand. Aerosol routes such as flame spray pyrolysis (FSP) and plasma spray pyrolysis (PSP) offer continuous synthesis on seconds-to-minutes timescales and may reduce downstream thermal processing, aqueous waste generation, and sensitivity to liquid-phase precursor mixing. FSP synthesis of NMC811 has been demonstrated experimentally, PSP synthesis of lithiated NMC-type oxides has been demonstrated for Mn-rich compositions, and prior techno-economic analysis has evaluated FSP for NMC333. To our knowledge, the economic competitiveness of PSP relative to FSP and conventional co-precipitation for NMC811 remains unresolved, particularly under parameter uncertainty.

We develop process-level techno-economic models for NMC811 production by co-precipitation, FSP, and PSP using battery-grade Ni, Co, Mn, and Li precursors as inputs. The models include mass and energy balances, precursor utilization, powder collection efficiency, process yield, utility demand, plasma torch electrical load, calcination heat where applicable, and factored capital costs at AACE Class 4–5 accuracy. Monte Carlo simulation over production scale, electricity price, precursor cost, yield, powder collection efficiency, and capital cost is used to construct a competitiveness map identifying the conditions under which each synthesis route minimizes NMC811 production cost. Cell-level implications are evaluated using the STEER OpenCell platform, a bottom-up cell-cost model developed at Stanford.

The analysis identifies the aerosol-process parameters that most strongly control economic viability, including precursor choice, process yield, electricity intensity, powder collection efficiency, and production scale, and tests whether the process-intensification advantages of FSP and PSP translate into cost advantages at scale. The results provide quantitative R&D targets for aerosol-based cathode synthesis.

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9NP.2

Laser-Induced Incandescence for In-Situ Carbon Nanotube Reactor Diagnostics. MICHAEL LARSON, Adam Boies, *Stanford University*

Floating catalyst chemical vapor deposition (FCCVD) is a promising route for the scalable synthesis of carbon nanotube (CNT) materials, but its development is still limited by a lack of in-situ diagnostics capable of probing particle evolution directly inside the reactor. In practice, much of reactor development still relies on ex-situ characterization of collected product, leading to a largely "blind" process of tuning temperature, flow conditions, precursor delivery, and reactor geometry. This trial-and-error optimization is a major obstacle to developing scientifically grounded understanding of CNT formation and, in turn, to designing reactors in a more informed and controlled way.

This work explores laser-induced incandescence (LII) as a foundation for in-situ diagnostics in FCCVD systems. LII is a laser-based diagnostic in which nanoparticles are briefly heated and characterized through their emitted thermal radiation. While widely used in soot studies, its extension to CNT synthesis offers an opportunity to move beyond endpoint product analysis and toward direct observation of particle behavior under reactor conditions.

The broader aim of this work is threefold: first, to establish an in-situ diagnostic framework that can ultimately be generalized across gas-phase nanomaterial synthesis systems; second, to improve scientific understanding of synthesis processes by linking measured optical signals to particle evolution in the reactor; and third, to enable better informed reactor design by replacing blind optimization with measurement-guided interpretation. To support these goals, a modeling and measurement framework is developed for interpreting LII signals in CNT FCCVD environments, with emphasis on how that information can guide subsequent reactor and diagnostic development.

By shifting attention from collected product to reactor evolution, this work seeks to lay the groundwork for more quantitative, physically informed synthesis studies and for diagnostic tools that can support the scale-up and control of nanomaterial reactors.

9NP.3

Optical Properties of Silicate Aerosols in Extra-Solar Planets. LIAM LEONARD, Hannah Wakeford, Jonathan P. Reid, Adam Boies, *University of Bristol*

Silicate aerosols have been detected throughout the universe and have been observed to form clouds in the atmospheres of brown dwarfs and exoplanets. However, their properties at the high temperatures (> 1,000 K) where they first condense out from the gas phase remain poorly understood. This project aims to understand how these particles form and how their properties influence interactions with light. To address this, high-temperature laboratory measurements will be conducted to synthesise silicate nanoparticles and measure their optical properties as a function of temperature, particle size distribution, morphology and wavelength. These measurements will be analysed using a Bayesian inference model to assess how particle properties and experimental conditions influence observed spectra. These laboratory measurements are essential to better understand and interpret the role of silicate clouds in the energy budget of hot and young planetary atmospheres. The results will be incorporated into atmospheric cloud models to simulate how silicate aerosols interact with radiation in substellar atmospheres. By providing new experimental constraints on silicate behaviour, this work will improve the interpretation of planetary spectra, enable the inference of atmospheric properties from these observations and increase the accuracy of atmospheric models.

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9NP.5

In-Situ Reactive TEM Study of the Oxidation Kinetics of Metal Nanoparticles. Kerin Shi, MICHAEL ZACHARIAH, *University of California, Riverside*

This study evaluates the oxidation kinetics of aluminum and Mg nanoparticles from 25 to 1000 °C by in-situ reactive cell transmission electron microscopy. For aluminum nanoparticles the oxidation can be divided into three stages from 25 to 1000 °C. The first heating stage is absent any discernible chemistry from 25 to ~ 600 °C. A low temperature oxidation stage from ~ 600 to ~ 800 °C, with an irregular volume increase, where the reaction rate is limited by oxygen diffusing through the alumina shell. A third high temperature oxidation stage from ~ 800 to 1000 °C corresponding to Al diffusing outward through the alumina shell ultimately leads to hollow particles. Using quantitative temporal imaging of the evolution of the particle morphology under oxidation conditions a reaction flux and diffusivity are determined. Comparison with other methods in the literature we find a clear trend that the measured diffusivity scales with heating rate, which likely explains the wide disparity of diffusivities reported in the literature. Results for similar studies on Mg and MgH2 will be presented.

9NP.6

Facile One Step Aerosol Synthesis of Sulfur Doped Carbon Dots via Flame Spray Pyrolysis: A Pathway to Continuous and Scalable Synthesis Route. MUHAMMAD TANVEER, Tuukka Kokkola, Kinga Skalska, Olli Sippula, Anna Lähde, *University of Eastern Finland, Kuopio, Finland*

Carbon dots (CDs) exhibit quasi spherical nanostructure with few nanometer size. Their size dependent optical features and quantum confinement behavior make them promising candidate for photocatalysis, biological sensing, solar cells and optoelectronics applications. Despite intensive activity, flame-based CD synthesis has rarely delivered controllable in situ heteroatom doping, and thus the mechanistic understanding is limited because particle formation and growth occur on millisecond timescales and are difficult to interrogate without perturbing the flame. Moreover, most reported flame routes still depend on post-synthetic purification or functionalization to achieve targeted surface chemistry. In this study, a novel synthesis methodology employing modified flame spray pyrolysis (FSP) configuration is presented for the synthesis of sulfur doped CDs integrating high-temperature in-flame sampling followed by ultrafast quenching to capture transient intermediates. A newly developed sampling probe, coupled to real-time aerosol instrumentation, extracts nascent particles at well-defined heights above the burner, providing time-resolved access to gas-to-particle conversion, inception, and growth under controlled combustion regimes. By tuning the flame from lean to rich conditions, the sulfur-governed formation pathways were systematically studied. Under lean operation, sulfur addition markedly promotes early carbon nanoparticle inception. On the other hand, under rich operation, the emergence of sulfur-containing oxidants (e.g., SO_2 and C-SO_3H and C-SO_4) limits excessive polycyclic aromatic hydrocarbon (PAH) buildup, thereby suppressing uncontrolled soot-like growth and favouring the formation of ultrasmall CDs. These mechanistic trends are directly reflected in real-time fast mobility particle sizer (FMPS) data, which show that sulfur strongly reshapes particle number concentrations and mobility-size distributions throughout the growth zone. XPS analysis confirms the presence of C-SO_3H and C-SO_4 functional groups on the surface of CDs, ensuring boding configurations and modification of the surface chemistry of the nanostructures. TEM analysis shows that primary particle size of CDs is 3.2 nm exhibiting graphitic core with interlayer spacing 0.19 nm. S doping promotes structural reordering and compact arrangement, resulting in shrinking of interlayer spacing. Doping also induces defects in the graphitic core as evidenced by the Raman analysis. S doping also promotes redshift absorption and photoluminescence features in CDs. Results show that heteroatoms extend the visible absorption and contribute to intense excitation dependent emission in both UV and visible regions. Defect induced structure and compact graphitic core of heteroatoms lead to redshifted photoluminescence features.

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9NP.7

Autonomous Spark Generated Catalyst Aerosols. MADELEINE SWINT, Hao Zhang, Arthur Sloan, Adam Boies, *Stanford University*

Autonomous experimentation offers a pathway for accelerating the discovery and optimization of aerosolized catalyst materials. In this research a spark discharge generator (SDG) was integrated with a flame ionization detector (FID) and a scanning mobility particle sizer (SMPS) for automated synthesis and evaluation of catalyst aerosols using the open-source Autonomous Research System (ARES OS) software developed by the Air Force Research Lab to allow for the rapid development of catalytic materials. SDG produces nanoparticles through electrical discharge between conductive wire electrodes, generating high-temperature plasma via ablated electrode material which rapidly quenches to form highly tunable nanoscale aerosols with compositionally interesting properties. The SMPS provides in-line feedback on the concentration of the produced particles whereas the FID provides a measurement of catalyst activity for ambient methane oxidation. The ARES OS software manages communication between these experimental elements and analysis or machine learning planning routines enabling closed-loop experimental planning, execution, and analysis. As a proof of concept in a 1-parameter system, Bayesian optimization was implemented to autonomously vary synthesis gas flow rates, thus identifying operating conditions maximizing nanoparticle generation as recorded by condensation particle counting (CPC). This study expands this system to show catalysts can be effectively synthesized and activity measured via CPC, SMPS, and FID where composition and concentrations of particles are readily controlled though SDG production by varying parameters such as electrode materials, gap distance between electrodes, applied voltage, and sweep gas velocity. Physical integration of this setup with machine learning technology allows for rapid autonomous materials generation and evaluation, significantly accelerating the catalyst discovery process.

9NP.8

In Situ Optimization of Crystalline Magnesium Nanoparticles for Plasmonic Applications. CHEYENNE HALVERSON, Adam Boies, *Stanford University*

Plasmonic materials interact with light through a collective oscillation of free electrons on their surface, producing particularly strong interactions between light and matter. Currently, gold and silver are the most stable materials that exhibit these properties, but they are precious metals that are difficult to integrate into silicon-based electronics. However, research suggests that other metal nanoparticles with crystalline morphologies could exhibit plasmonic responses and enable easier integration into nanoelectronics. This study aims to identify, produce, and test nanoparticle morphologies demonstrating high plasmonic responses.

Generating magnesium nanoparticles through a vapor-to-solid phase transition can result in the development of crystalline structures, such as waisted prisms, polyhedral particles, and hexagonal plates. These nanostructures have particularly large surface areas, as well as reactive edges and corners that have the potential to manipulate light at the nanoscale. This research seeks to determine the plasmonic properties and applications of these crystalline particles.

The Silver Particle Generator (SPG) reliably generates nanoparticles with tunable sizes, concentrations, and morphologies through the vapor-to-solid phase transition. The SPG produces nanoparticles from various materials by vaporizing the bulk material in a tube furnace and cooling the vapor downstream, causing the particles to nucleate and coalesce into larger nanoparticles. The nanoparticle synthesis is accompanied by measurements from a scanning mobility particle sizer (SMPS) as well as a centrifugal particle mass analyzer (CPMA) to identify the mass and size of the generated particles in real time. Ultraviolet-visible (UV-Vis) spectroscopy is also used to identify the plasmonic response of the generated nanoparticles in real time. This data is used to adjust the furnace parameters in situ to optimize the generated particles for the intended plasmonic response.

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9SA.1

Impact of Shipping Emission Regulations on Coastal and Marine Atmospheric Vanadium - Insights from Long-Term IMPROVE Monitoring Sites and NASA ACTIVATE Cloud Observations. FRANCESCA GALLO, Armin Sorooshian, Luke Ziemba, Grace Betito, Andrea F. Corral, Ewan Crosbie, Eva-Lou Edwards, Miguel Hilario, Simon Kirschler, Claire Robinson, Michael Shook, Kenneth Thornhill, Christiane Voigt, Edward Winstead, Kira Zeider, Richard Moore, *NASA Langley*

Ship emissions from residual fuel oil (RFO) are a well-known source of coastal air pollution, releasing sulfur oxides and $PM_{2.5}$ enriched in vanadium and nickel. To reduce these impacts, the International Maritime Organization (IMO) established Sulfur Emission Control Areas, requiring vessels operating near coastlines to switch to low-sulfur marine fuels. This study evaluates the effectiveness of these regulations by combining 15 years of chemically speciated $PM_{2.5}$ measurements from IMPROVE monitoring sites along the U.S. East Coast with in-cloud observations collected from the 2020–2022 NASA ACTIVATE airborne campaign over the northwest Atlantic. Following the implementation of IMO regulations, we found statistically significant decreases in ambient V (80–89%), particulate Ni (67–79%), and sulfate (53–59%) at coastal sites. Furthermore, we show that the vanadium-to-nickel ratio, traditionally used as a fingerprint for RFO combustion, is no longer a reliable marker in the current regulatory environment, while vanadium concentration alone represents a stronger ship marker. Additionally, our analysis indicates that, under the current low-sulfur fuel regime, cloud water vanadium concentrations over the northwest Atlantic are approximately an order of magnitude lower than $PM_{2.5}$ levels at coastal sites. However, elevated concentrations of vanadium in cloud droplets enriched in non-sea-salt sulfate and nitrate suggest a potential role of ship-emitted vanadium in catalyzing in-cloud oxidation reactions.

9SA.3

Eastern Coachella Valley (ECV) Dust Characterization Study: Trends (2022-2026) in PM10 Chemical Composition and Sources . JOSEPH SALAZAR, Yumeng Cui, Julia Montoya-Aguilera, Christopher Lim, Provat Saha, Zihan Zhu, Steven Boddeker, Freyja Berg Lopez, Laura Saucedo, Cynthia Berg, Angela Haar, James Rothchild, Eric Holden, Mohammad Sowlat, Payam Pakbin, Stephen Dutz, Jason Low, *South Coast Air Quality Management District*

The enactment of Assembly Bill (AB) 617 by the California legislature and establishment of the Community Air Protection Program (CAPP) by the California Air Resources Board (CARB) provided the opportunity for South Coast Air Quality Management District (South Coast AQMD) to further address air quality issues in communities disproportionately impacted by air pollution, including Eastern Coachella Valley (ECV in the Salton Sea Air Basin. The ECV community is impacted by multiple sources of dust, including emissions from the surrounding deserts, a emissions associated with the drying Salton Sea and the exposed playa, agricultural and industrial activities, and emissions from unpaved roads. Building on a previously established 2022-2023 baseline, South Coast AQMD continued monitoring in ECV through 2026 to evaluate longer-term trends in PM10 mass and composition (e.g., carbon, elements and metals).

This study summarizes four years of measurements (2022-2026), with emphasis on the expanded 2023-2026 dataset and near real-time monitoring of PM10, black carbon (BC), total carbon (TC), organic carbon (OC), and elements and metals. Continuous and time-integrated speciated measurements are integrated to characterize temporal patterns across hourly, daily, seasonal, and multi-year timescales. The data is used to assess how PM10 composition and source-related indicators have evolved relative to the earlier baseline period (2022 – 2023), and to identify periods when dust, combustion-related emissions, and metal-rich episodes most strongly influence community exposure.

Extending the measurements beyond the initial study provides insight into interannual variability in dust levels and contributions within ECV and improves understanding of the relative influence of natural and anthropogenic sources. The resulting dataset supports ongoing source identification, informs interpretation of near real-time PM10, and provides updated information on changes in community-level air pollution. These findings can help inform future emission reduction and exposure mitigation strategies under the AB 617 program.

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9SA.4

Spatiotemporal Analysis of Ambient Chiral VOC Concentration and Composition in Los Angeles. MEGAN HARMON, Jackson Ryan, Thaomy Vo, William Berelson, Celia Faiola, *University of California, Irvine*

Volatile Organic Compounds (VOCs) are an important precursor to ozone and secondary organic aerosol (SOA) in urban environments, contributing to air pollution with negative health impacts. Urban environments contain a complex mix of anthropogenic (AVOCs) and biogenic (BVOCs) VOCs, and separating these sources is critical to implementing effective air pollution mitigation strategies. In recent decades, VOCs from mobile sources have decreased significantly and leveled off in Los Angeles, making BVOCs and other AVOCs, such as volatile chemical products (VCPs), more significant. Seasonal and diel trends in VOC concentrations and enantiomeric ratios can provide insight into their sources. This study collected ambient VOC measurements in downtown Los Angeles (LA) and at a downwind site. Samples were collected using an automated adsorbent cartridge sampler and were subsequently analyzed offline with a TD-GC/MS system equipped with a chiral column. We present diel profiles and enantiomeric ratios at these sites and use those trends for source apportionment. Over the course of a year, we have consistently seen (+) limonene in significant enantiomeric excess in downtown LA which supports previous work suggesting that there is a strong anthropogenic influence at the site that we attribute to VCPs. Since the downwind site is less populous and encompasses more greenery, we expect to observe a more prevalent biogenic influence in total enantiomers possibly resulting in a different enantiomeric excess. Ultimately, this work can help inform emission inventories, models, and provide a new method for VOC source apportionment in urban areas.

9SA.5

A Low-Cost Approach for Black Carbon Source Apportionment in the Global South. RAFAEL BRAGA GOMES, Maisha Agarwal, Faith Chiarappa, Annika Khurana, Tracy Lu, Andrew Song, Prithviraj Vijayaraj, Albert Presto, *Carnegie Mellon University*

Black Carbon (BC) is a super-pollutant produced by incomplete combustion and a major contributor to fine particulate matter mass ($PM_{2.5}$). Emissions inventories estimate that the Global South accounted for approximately 85% of global BC emissions in 2022 (Hoesly et al., 2024). However, recent evaluations indicate that these inventories underestimated ambient concentrations by up to a factor of 4 in the Global South (Ren et al., 2025). The lack of ground-truth source apportioned measurements introduces significant uncertainties into regional emissions inventories and chemical transport models. Building on a previous low-cost BC quantification method (Anand et al., 2023), this research introduces a low-cost imaging analysis technique that uses archived hourly $PM_{2.5}$ filter samples collected by Beta Attenuation Monitors (BAMs) deployed at U.S. Embassies in 12 cities across Africa and Asia. By leveraging reference samples loaded with traffic pollution and laboratory-generated aerosols from biomass burning, we identified source-specific spectral responses using camera-derived Absorption Angström Exponent (AAE) values. Experimental analysis revealed distinct spectral responses, yielding a median AAE of 3.21 for biomass burning (n=29) and 1.37 for fossil fuels (n=29). Site-specific source apportionment was determined by anchoring liquid-fuel and solid-fuel sources to the 1st and 99th percentiles of the AAE distributions, respectively, while accounting for seasonal aerosol changes (following Savadkoohi et al., 2025). Field validation demonstrated that the camera method closely tracks the diurnal performance of a research-grade, co-located Aethalometer during a campaign in Addis Ababa, Ethiopia, from March through June 2023. Applying this technique to an initial subset of six sites revealed that source-specific contributions of BC to $PM_{2.5}$ vary significantly across the Global South, with fossil fuel BC accounting for 7.0–14.0% of total $PM_{2.5}$, compared with 2.9–6.9% from biomass burning. Knowing these contributions provides the necessary ground truth to improve emissions estimates and chemical transport modeling of global BC pollution.

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9SA.6

PM2.5 Sources and Regional Transport in Thailand and Lao PDR. SUJUNG HAN, Taeyeon Kim, Yein Kim, Jang-Pyo Cheong, Kiyoung Lee, Seung-Muk Yi, *Seoul National University, Seoul, Korea*

Population growth, urbanization, industrial activities, and pervasive biomass burning have increased $PM_{2.5}$ mass concentrations across Southeast Asia, posing substantial risks to public health. While various emission control policies have been implemented, the scientific evidence available to support air quality management remains limited in many Southeast Asian nations. To overcome these limitations, the present study resolves the sources of $PM_{2.5}$ and quantifies their contributions at three locations: Chiang Rai and Bangkok in Thailand, and Vientiane in Lao PDR.

$PM_{2.5}$ samples were collected using three types of filters (Teflon, Quartz, Nylon) at 1-in-3 day intervals for two years (2023-2026). The Teflon filters were used to measure $PM_{2.5}$ mass concentrations using an automatic system and 20 species of trace elements (Cl, Al, Ca, etc.) using Energy Dispersive X-ray Fluorescence (ED-XRF). Carbonaceous species (OC, EC) were analyzed using the OC/EC aerosol analyzer on Quartz filters, while 6 ionic species (NO_3^-, SO_4^{2-}, Cl^-, NH_4^+, Na^+, and K^+) were measured with Ion Chromatography on Nylon filters.

The positive matrix factorization (PMF) model was used to identify and quantify the sources of $PM_{2.5}$. The conventional Bivariate Probability Function (CBPF) model was used for the directional analysis of $PM_{2.5}$. The study investigated variations in $PM_{2.5}$ mass concentrations by comparing the wet and dry seasons, providing insights into seasonal differences.

Source apportionment was conducted using Positive Matrix Factorization (PMF) to resolve sources and quantify their contributions. To identify probable source locations, the Conditional Bivariate Probability Function (CBPF) and the Potential Source Contribution Function (PSCF) were used to characterize the influence of local meteorology and regional transboundary transport, respectively.

Acknowledgment
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9SA.7

Causal Discovery for PM2.5 Source Attribution in African Metropolitan Airsheds. PAA SEY, Paulina Jaramillo, Albert Presto, *Carnegie Mellon University*

Sub-Saharan Africa carries one of the world’s largest $PM_{2.5}$ health burdens, yet has the sparsest reference-grade monitoring infrastructure of any inhabited continent. Source apportionment of urban $PM_{2.5}$ is conventionally addressed through receptor models such as Positive Matrix Factorization and Chemical Mass Balance, which require speciated PM2.5 composition obtained via filter-based sampling or aerosol mass spectrometry. Such data are available at only a handful of African cities, leaving source attribution unresolved across the majority of African urban airsheds. We present a complementary framework that infers the dominant sources of $PM_{2.5}$ from routinely measured trace-gas concentrations (NO_2, CO, SO_2, HCHO) and meteorological covariates, without requiring speciated $PM_{2.5}$ composition. The framework applies time-series causal discovery (PCMCI+) to identify the precursor and meteorological variables that directly modulate day-to-day variability in $PM_{2.5}$ concentration. Each candidate causal link is evaluated against three diagnostics: false-discovery-rate-controlled significance, bootstrap stability under resampling, and predictor collinearity. The contribution of each surviving causal link is then quantified via Wright’s path-coefficient decomposition, determining the $PM_{2.5}$ response to a typical day-to-day shift in the source’s surface concentration. We apply the framework across three monitoring networks: U.S. embassy AirNow monitors, multipollutant ground stations in Kigali, Rwanda, operated by the Rwanda Environment Management Authority (REMA), and multipollutant ground stations in South Africa’s Highveld, operated by the South African Air Quality Information System (SAAQIS). At Mont Kigali, the framework recovers ambient CO, a gaseous byproduct of the incomplete combustion processes that co-emit primary carbonaceous particulate matter and secondary aerosol precursors, as the leading contributor to day-to-day $PM_{2.5}$ variability during the dry-warm season, where a typical shift in CO corresponds to a +16.0 μg m^{-3} response in $PM_{2.5}$, and the recovered source set explains 80% of within-season day-to-day variance.

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9SA.8

Source Apportionment and Characterization of Urban Emissions Using Fixed and Mobile Measurements near Airport and Rail Corridors in Los Angeles. KYLE CAULSON, Zhuoying Lin, Alex Chang, Shenglun Wu, Morteza Amini, Suzanne E. Paulson, *University of California, Los Angeles*

Transportation related emissions in major urban areas, including particulate matter (PM), black carbon, and various gaseous compounds, contribute significantly to ambient air pollution. Strong spatial gradients and diverse emission sources can produce substantial variability in pollutant concentrations over short temporal scales. In a complex environment like Los Angeles, emissions from roadways, railways, airports, and nearby industrial sources, among others, can often occur concurrently and interact within the same environment. Separating contributions from these overlapping emissions remains a major challenge for exposure assessments and source attribution.

In the fall of 2025, we conducted 14 days of measurements using the California Air Resources Board's mobile sampling platform, measuring particle number and size distributions, black carbon, and select gas tracers including NOx and CO2. Stationary measurements were collected adjacent to a major rail line to capture locomotive related emissions, and semi-mobile monitoring was conducted near the Los Angeles International Airport to characterize spatial variability associated with aircraft activity and surrounding roadway sources.

To differentiate emissions associated with aircraft operations, rail locomotives, and other urban sources, we apply matrix factorization and receptor modeling techniques to our multipollutant dataset. We use PM, black carbon, and gas measurements to separate different operational configurations for aircraft, as well as mechanical vs. combustion related emissions from locomotives. Additionally, we use CO2 measurements to estimate emission factors. Our findings will provide insight into localized exposure patterns near major transportation corridors and support future air quality management efforts in Los Angeles.

9SA.9

Real-World Emission Dynamics and Compositional Identification of Airborne Tire and Road Wear Particles. SALAHUDDIN SETU, Hosein Foroutan, *Virginia Tech*

Vehicular non-exhaust emissions are emerging as a dominant contributor to traffic-related particulate matter (PM) as exhaust emissions decline under tightening regulations, advanced engine technologies, and the electrification of vehicle fleets. Among non-exhaust sources, tire and road wear particles (TRWPs) are of particular concern, and are projected to become the leading non-exhaust PM source in urban environments. In this study, we investigate airborne TRWP emissions under realistic on-road driving conditions. An instrumented vehicle equipped with a TRWP sampling system, consisting of a multi-stage cascade impactor, an aerodynamic particle sizer, and a DustTrak aerosol monitor, was deployed to collect real-time, size-resolved particle measurements. On-road tests were conducted at an access-controlled facility across three roadway types: highway, surface street, and rural road. A range of real-world driving maneuvers – including fixed-speed driving, acceleration, deceleration, cornering, lane changes, and U-turns – were systematically evaluated along with roadway features including pavement type and roadway grade. Results showed linear increases in TRWP emissions with driving speed as well as acceleration and deceleration intensity, while sharp cornering and U-turns produced the highest emissions due to increased lateral shear. Individual driving maneuvers also affected fine and coarse particle generation differently, with $PM_{2.5}$-to-PM_{10} ratios ranging from 0.49 to 0.82 across driving conditions. Despite the wealth of real-time emission data captured, a key challenge in TRWP analysis is that tire wear particles (TWPs) are often generated with, or encrusted by, road wear particles (RWPs) – a distinction that matters because TWPs and RWPs carry distinct chemical compositions, toxicological profiles, and regulatory implications, making accurate source apportionment critical. To address this, size-segregated filter samples were analyzed using a correlated RISE workflow – combining Raman spectroscopy, scanning electron microscopy, and energy-dispersive X-ray spectroscopy – to capture chemical, morphological, and elemental signatures at the single-particle level, which were then integrated using a multi-view conformal prediction framework to probabilistically estimate TWP, RWP, and other particle fractions. Overall, this study advances understanding of airborne TRWP emission dynamics across real-world driving conditions and presents a robust, transferable framework for source-specific particle identification in complex mixed-particle samples.

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9SA.12

Dicyclohexylamine: A Potential Non-Exhaust Traffic Emission Marker. BERENICE ROJAS, Véronique Perraud, Kiana Boyd, B. Sage Lauper-Cook, Adam Thomas, Lisa Wingen, Madeline Cooke, Manabu Shiraiwa, Barbara Finlayson-Pitts, James Smith, *University of California, Irvine*

Urban air pollution remains a major environmental challenge. Although decades of regulations have substantially reduced vehicle exhaust emissions, non-exhaust sources such as brake wear, tire wear, and resuspended road dust now account for more than half of traffic-related particulate matter (PM) mass in urban environments. Although different trace metals have previously been used to assess the contribution of non-exhaust sources, distinct organic molecular markers are lacking, thus introducing significant uncertainties into quantitative assessments of the sources. Here, using laboratory experiments, we investigate dicyclohexylamine (DCHA, C12H23N), an amine detected in near-road environments, as a potential marker of non-exhaust emissions.

Brake wear particles (BWP) were generated using a custom-built dynamometer with ceramic and semi-metallic brake pads and collected on filters. Phenolic resin particles were collected in filters from controlled thermal degradation experiments. Brake pad fragments, and cryo-milled tire tread samples were also analyzed. All samples were analyzed using liquid chromatography coupled with high-resolution Orbitrap mass spectrometry. DCHA was consistently detected in BWP and cryo-milled tire tread samples, with PM-normalized concentrations ranging from 0.08 ± 0.10 to 1.60 ± 0.13 ng μg^{-1} for ceramic and semi-metallic BWP respectively, and 0.02 to 0.20 ng μg^{-1} for cryo-milled tire treads. DCHA was below detection limits in bulk brake pad fragments. Phenolic resin experiments produced DCHA of 0.85 ± 0.30 ng μg^{-1} during thermal degradation in the range of 200-300 °C, within the range detected from the BWP filters. The lower concentrations in cryo-milled tire treads, and the comparable concentrations between phenolic resin and BWP, suggest that DCHA is associated more with high-temperature braking processes than with its presence as a bulk constituent in brake or tire materials. Implications for non-tailpipe emissions of DCHA in urban areas will be discussed.

9SA.13

Investigating the Impact of Canadian Wildfire Plumes on Aerosol Levels and Properties in Atlanta in Summer 2025. SOPHIA HOCH, Sohyeon Jeon, Ruizhe Liu, David Pando Gonzalez, Yutong Liang, Nga Lee Ng, *Georgia Institute of Technology*

Wildfire events across North America are becoming increasingly frequent and severe, but the degree to which transported smoke plumes affect local and downwind fine particulate matter ($PM_{2.5}$) remains poorly constrained. Biogenic secondary organic aerosols (SOA) from isoprene and monoterpene oxidation dominate $PM_{2.5}$ in the southeastern US, including Atlanta, Georgia. With its dense urban tree canopy and downwind position of Canadian wildfire plumes, the region offers a natural laboratory to examine interactions between local background and biomass burning aerosols. In this work, we investigate how Canadian wildfire smoke plumes in summer 2025 impact aerosol levels and properties in Atlanta. A Filter Inlet for Gases and AEROsols coupled to a Chemical Ionization Mass Spectrometer (FIGAERO-CIMS) is deployed to characterize molecular-level interactions, supplemented by collocated ASCENT chemical composition data and Georgia Environmental Protection Division meteorological observations. Canadian wildfire and other types of plume events are captured and identified using biomass burning and smoke tracers measured across the instrument suite. We distinguish a biomass burning oxygenated organic aerosol (BBOOA) factor from background aerosol factors through positive matrix factorization (PMF) analysis of FIGAERO-CIMS data, allowing for evaluation of how biomass burning affects background aerosols. Preliminary results indicate that during Canadian wildfire plume influence, background aerosols in the Atlanta area are enhanced. Understanding these wildfire plume-local pollutant interactions is critical for accurately evaluating the full downwind impact of wildfire emissions.

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9SA.14

Source-Specific Radioactivity and Oxidative Potential of Urban PM2.5. JIEUN PARK, Taeyeon Kim, Hyejin Shin, Minsoo Kang, Sung Hoon Jeong, Donghyun Rim, Philip K. Hopke, Seung-Muk Yi, Petros Koutrakis, *Ewha Womans University*

Radioactive constituents of fine particulate matter ($PM_{2.5}$) are an underrecognized dimension of urban air pollution, posing emerging challenges for sustainable public health management. In this study, we experimentally demonstrate a mechanistic link between particle radioactivity (PR) and oxidative potential in the urban atmosphere by integrating alpha and beta activity measurements of long-lived radon progeny (^{210}Pb, ^{210}Bi, ^{210}Po) with dithiothreitol (DTT) assays. Using source apportionment, we present the first integrated evidence that biomass burning and industrial activity jointly drive both radiological activity and oxidative potential, highlighting a shared source-specific toxicity profile for $PM_{2.5}$. Our results establish PR as an emerging, particle-bound radiological indicator of $PM_{2.5}$ oxidative potential, offering source-specific insights with potential applications in air quality and health-relevant regulations. Recognizing the intrinsic coupling of radiological and chemical reactivities provides a new framework for evaluating synergistic health risks beyond conventional mass-based air quality metrics.

9SA.15

Machine Learning-Based Estimation of PM2.5 Source Contributions Derived from Positive Matrix Factorization (PMF). TAEYEON KIM, Sujung Han, Hyejin Shin, Kwon Ho Jeon, Seung-Muk Yi, *Seoul National University*

Growing epidemiological evidence indicates that the health effects of $PM_{2.5}$ depend significantly on its chemical constituents. In addition, to establish targeted air quality management and policies, source-specific epidemiological studies are crucial. However, expanding chemical speciation networks is constrained by high instrumentation costs. Consequently, health studies often rely on ambient speciation data from distant regional supersites, introducing exposure misclassification.

This study aims to develop a machine learning-based framework to predict source contributions in unmonitored areas near the intensive monitoring sites. The study region is Seoul, South Korea, influenced by diverse urban emissions and adjacent industrial complexes. We utilized $PM_{2.5}$ mass and chemical speciation data collected from the Seoul Metropolitan Area (SMA) Air Quality Research Center in northern Seoul and Seoul National University (SNU) in southern Seoul.

Positive Matrix Factorization (PMF) was performed to quantify source contributions. An XGBoost Regressor was constructed to predict source contributions at the SNU site by integrating the PMF-derived source contributions at SMA site with air quality monitoring network data, meteorological data, and traffics. The predictive model was evaluated by comparing the simulated estimates against the PMF-derived source contributions obtained from the SNU site. Hyperparameters were optimized via random search cross-validation. Furthermore, SHAP (SHapley Additive exPlanations) analysis was conducted to interpret feature importance for each source contribution. Preliminary results indicate that the predictive performance varied distinctly across different sources. Secondary nitrate showed high r^2, heavily driven by gaseous precursor concentrations and seasonal meteorological indicators. Soil source, closely associated with PM_{10} mass, also demonstrated high explanatory power. Conversely, primary sources dependent on trace element tracers, such as coal and oil combustion, exhibited lower predictive accuracy.

In conclusion, this study highlights the potential of using data from intensive speciation sites to reconstruct regional-scale source distributions. Additionally, this framework can provide appropriate datasets to support source-specific $PM_{2.5}$ epidemiological studies.

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9SA.16

Investigating NOx Variability in the San Joaquin Valley Using Long-Term Stationary Monitoring Data. GEORGES SALIBA, Morteza Amini, Angelica Carrazco, Emily Yang, Jason Schroeder, Majiong Jiang, Michael FitzGibbon, *Research Division, California Air Resources Board*

California's San Joaquin Valley (SJV) remains in extreme nonattainment for ozone national ambient air quality standards (NAAQS) and serious for fine particulate matter (PM2.5) NAAQS. Nitrogen oxides (NOx) are key precursors to both ozone and PM2.5. Comparisons between satellite images and air quality modeling outputs over agricultural areas reveal a NO2 discrepancy over the SJV for certain months and years, and some studies suggest that agriculture and soil NOx emissions may be underrepresented in current emission inventories. Long-term U.S. EPA Air Quality System (AQS) monitoring data from 5 rural sites were used to characterize ambient NOx trends and variability across the SJV, and to test for an agricultural soil emission signature in measured ambient concentrations. Ambient NOx generally declined at all sites, but reductions slowed at rural sites after 2017. Furthermore, summertime (May-September) rural NOx ambient concentrations were similar to or higher than those measured in urban Fresno. Statistical analysis combined tracer correlations, principal component analysis, and multi-linear regression analysis to reveal that NOx variability is positively correlated with a combustion tracer in winter but with an agricultural tracer in summer. Leveraging long-term precipitation data also indicated post-rain enhancements in NO, N2O, and CO2 concentrations – but not CO – in a rural site during summer, consistent with soil pulses. These results may suggest agricultural contributions to ambient NOx though this study characterizes variability rather than absolute emissions. Sustained NOx flux measurements in the SJV would yield deeper insights into the pulse effect, helping to constrain the soil emission parameterizations in models. The measurements can also provide important information for evaluating NOx contributions from other emission sources.

9SA.17

Source Apportionment of Organic Aerosols and Trace Elements in California's Inland Empire: A 15-Month Positive Matrix Factorization Study at Rubidoux. BRADLEY RIES, Gino Pena, Tiffany Hu, Erin Bowey, Yumeng Cui, Sean Raffuse, Ann M. Dillner, Armistead G. Russell, Nga Lee Ng, Roya Bahreini, *University of California, Riverside*

Particulate matter (PM) in the South Coast Air Basin poses persistent air quality challenges from diverse vehicular, industrial, and other combustion-related sources. We present source apportionment results from 15 months of concurrent measurements (September 2023–December 2024) at the Rubidoux ASCENT site in Riverside, California, using an Aerosol Chemical Speciation Monitor and an X-ray fluorescence-metals monitoring instrument (Xact 625i). Positive Matrix Factorization (PMF) was applied simultaneously to both datasets using the ME-2 solver in the SoFi framework, enabling co-resolving of organic and elemental sources within a single factor solution. The combined analysis resolved eight factors: hydrocarbon-like OA with an elemental traffic signature, biomass burning OA (BBOA), less oxidized OOA (LO-OOA), local LO-OOA, more-oxidized OOA (MO-OOA) enriched in Sulfur and Nickel, a regional MO-OOA, cooking OA, and an Industry factor. The main advantage of joining these two instruments together into one PMF run is the ability to resolve factors that are ambiguous or invisible in either instrument's dataset alone. Most notably, the HOA+Traffic Factor which is dominated by organic markers, would not be able to be separated from the brake and tire factors in an Xact-only solution, yet was clearly resolved with the inclusion of ACSM organic mass spectra. PMF analysis on this length of dataset was able to highlight significant seasonal variations within each factor. BBOA increased substantially during winter, aligning with residential wood burning. Diurnal profiles of several factors highlighted competing boundary layer and photochemical dynamics: in winter, dilution from boundary layer growth drives a midday low across most factors, while in the summer, strong secondary production of OOA factors can overcome boundary layer dilution and produced a midday peak. HOA+Traffic factor peaked during morning commute hours and lessened on the weekends. Cooking OA was elevated in the evening. The Industry factor dominated elemental PM2.5 year-round.

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9SA.18

Composition and Source Apportionment of PM2.5 Aerosols at Joshua Tree National Park ASCENT Site: A Year-Long Perspective. GINO PENA, Bradley Ries, Tiffany Hu, Erin Bowey, Eleanor Bentley, Sean Raffuse, Ann M. Dillner, Armistead G. Russell, Nga Lee Ng, Lelia Hawkins, Roya Bahreini, *University of California, Riverside*

The Joshua Tree National Park (JTNP) is an arid desert situated downwind of populated cities in the Los Angeles Basin. Its unique geographical location makes it a historically polluted national park that often receives anthropogenic pollution including aerosols and their precursors. In addition to anthropogenic pollution, an increase in transported wildfire plumes have made them a particular interest to JTNP air quality. As part of the NSF-Funded ASCENT network, an Aerosol Chemical Speciation Monitor (ACSM), Xact-625i, AE33 aethalometer, and Scanning Mobility Particle Sizer (SMPS) were deployed since summer 2024 at JTNP Black Rock Campground to continuously characterize aerosol composition and size distribution. Of the species measured at the site, organic aerosols have shown to be the largest component of PM2.5 in all seasons. Using the Positive Matrix Factorization (PMF) Evaluation Tool (PET) v3.00A (Ulbrich et al., 2009), we were able to separate the organic aerosol mass spectral data into 3 factors (Hydrocarbon-like Organic Aerosols, HOA, Oxygenated Organic Aerosols, OOA, and Biomass Burning Organic Aerosols, BBOA) with distinct factor profiles. During wildfire events, the fractional contribution of BBOA to total non-refractory mass increased up to three-fold, creating a unique ambient profile with a prevalent presence of OA; concurrently, equivalent black carbon (eBC) concentrations increased dramatically during these times. In addition, back-trajectory cluster analysis using HYSPLIT and local meteorological conditions were considered to determine dominant wind directions and pollution origins impacting the site during and outside the windows of wildfire events. Overall, the instruments located at the JTNP ASCENT site, alongside source apportionment and back trajectory cluster analysis, allow for a more thorough PM2.5 characterization and insight into the source regions of aerosols observed at JTNP across different seasons.

9SA.19

Efficient Error-Weighted Positive Matrix Factorization for Large Atmospheric Mass Spectrometry Datasets. SEAN YOUN, Daven Henze, Pedro Campuzano-Jost, Donna Sueper, Luping Su, Manjula Canagaratna, Harald Stark, Douglas Worsnop, Jose-Luis Jimenez, *Univ. of Colorado, Boulder & Aerodyne Research Inc.*

Positive matrix factorization (PMF) is a widely used methodology for source apportionment and dimension reduction for environmental and atmospheric data. However, the growing size of such datasets owing to modern instrumentation with high spectral and sampling resolution, as well as longer deployments in the field, has led to factorizations being unwieldy for many widely used PMF solvers. We demonstrate that incorporation of probabilistic randomization methods can be used to significantly reduce the computational cost of PMF for error-weighted atmospheric mass spectrometry data, with little effect on solution error. Performance of the efficient error-weighted PMF algorithm is compared against reference solutions from both real and synthetic mass spectrometry datasets. Methods for incorporating a priori information into the factorization (including factor rotation and pulling), as well as regularization, in order to produce more physically meaningful and stable solutions are also discussed. We demonstrate an integrated workflow implementing this updated PMF algorithm into an existing visualization and diagnostic dashboard (PET) to facilitate run diagnosis and analysis.

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9WF.1

Ideas for Predicting Firebrand-Induced Spot Fires at the Point-of-Need: Insights from Spatter Transport in Metal Additive Manufacturing. NICHOLAS O'BRIEN, Satbir Singh, Jack Beuth, *Carnegie Mellon University*

Firebrands generated during wildfires can travel across roads and highways, landing in houses and starting spot fires miles from the original source. These firebrand-induced spot fires were one contributor to the unique severity of the 2025 California wildfires, showing the importance of accounting for this phenomenon in projecting wildfire spread. Unfortunately, existing models of firebrand transport are not yet simple enough for use by fire response teams, limiting their impact. This presentation thus proposes a potential method to create a faster running surrogate model of firebrand transport, borrowing from the authors' prior research in laser powder bed fusion additive manufacturing of metals (PBF-LB).

In PBF-LB, parts can develop defects due to contamination from microscopic spatter particles. Spatter particles are a byproduct of the printing process, being ejected from the laser-interaction zone and traveling up to 250 mm from the origin to contaminate other parts. PBF-LB machines attempt to remove spatter particles with a constant flowing inert gas like argon, but the gas flow does not always remove particles completely, leaving regions where contamination by spatter is highly likely. The author’s research in spatter transport has shown how a machine learning (ML) model can be trained to predict the landing sites of spatter particles quickly and accurately. While the spatter problem in PBF-LB is more controlled and operates on a smaller scale than firebrand transport, this presentation aims to help brainstorm how this concept could be transferred to incorporating firebrand transport into timely wildfire response planning at the wildland-urban interface. This presentation will discuss how the ML model is formulated and trained, and its incorporation into a build-planning application will be demonstrated.

9WF.2

Characterization of Particulate Matter and Heavy Metal Emissions During Electric Vehicle Fires. QIAN ZHANG, David Kalafut, Yin Yee (Cynthia) Choo, Patrick Chepaitis, Fatima Ahmad, Taryn Waddey, Richard Kesler, Gavin Horn, Adam Barowy, Mark Wilson, *UL Research Institutes*

Fires that happen at the wildland-urban interface (WUI), the zone of transition between unoccupied land and human development, create complex mixture emissions of particulate matter (PM), organic and inorganic gases, and metals. Electric vehicles (EVs) are an important factor in WUI fires, given their increasing market share in recent years. However, limited research exists about the emissions from EV fires, which include combustion products of battery packs, electronic parts, plastics, metal panels, and interior materials. Therefore, it is important to systematically characterize the emissions under controlled burn testing. In this study, an indoor large-fire laboratory was used for emission characterization of full-scale fires of EVs. Five EVs were studied with varied vehicle models (i.e. battery properties, exterior and interior materials) and fire suppression techniques (vehicle fire blanket, encapsulating agent, and water). Real-time airborne PM concentration was measured using DustTrak. $PM_{2.5}$ concentration and trend at different fire stages, e.g., ignition, battery thermal runaway, combustion, fire suppression, will be presented. In addition, PTFE filters were collected for metal analysis using inductively coupled plasma-mass spectrometry. Heavy metal composition and concentration in collected particles will be presented. The relationship between PM characteristics and the influencing factors, such as vehicle model, fire condition, and fire suppression technique, will be discussed. This study increases the knowledge of particle emissions during EV fires and provides insights into understanding exposure potentials associated with EV fires.

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9WF.3

Chemical Characterization of Gas- and Particle-Phase Emissions from Full-Scale Electric Vehicle Fires. YIN YEE (CYNTHIA) CHOO, David Kalafut, Qian Zhang, Patrick Chepaitis, Taryn Waddey, Fatima Ahmad, Richard Kesler, Gavin Horn, Adam Barowy, Mark Wilson, *UL Research Institutes*

The rapid global adoption of electric vehicles (EVs) is widely regarded as a strategy for reducing greenhouse gas emissions and improving urban air quality. However, in the context of increasingly frequent and intense Wildland–Urban Interface (WUI) fires, EVs represent an emerging and underexplored source of hazardous emissions. During WUI fires, vehicles are often exposed to extreme thermal conditions leading to battery thermal runaway and subsequent combustion. The emissions may contribute to inhalation exposures for nearby residents, firefighters, and cleanup personnel. This study, conducted in collaboration with the Fire Safety Research Institute, used a controlled large-scale indoor testing facility to perform full-scale EV fire tests. Two EV models were evaluated, representing differences in battery type and capacity. Experiments also incorporated multiple fire control approaches, including water, water with additive, and vehicle fire blanket with and without water application.

Air samples of combustion emissions were collected onto 2,4-dinitrophenylhydrazine (DNPH) and Tenax® TA sorbent tubes for aldehydes and volatile organic compounds (VOCs). A segmented sampling approach was used to capture emissions at distinct stages of combustion. Particulate matter (PM) was collected on glass fiber filters for the analysis of semi-volatile organic compounds (SVOCs), representing an exposure via inhalation of resuspended particles.

Preliminary results indicate that emissions are dominated by benzenoid, oxygenated, and halogenated organic compounds. Distinct chemical profiles and concentration patterns were observed across different stages of combustion. Emissions also varied by vehicle type and fire suppression method, suggesting that differences in battery chemistry, material composition, and suppression strategy influence both composition and magnitude of emissions. The presence of these compounds in both gas and particle phases indicates multiple exposure pathways, including inhalation of vapors and resuspended particulates are of concern. Together, these findings suggest elevated exposure risks, particularly for individuals near EV fire events or involved in firefighting and post-fire cleanup.

9WF.4

Mechanistic Understanding of Differential Metal Enrichment of Airborne Particles Versus Surface Dust from the 2025 Los Angeles Fires. QIYUE NIE, Yuan Yao, Jing Li, Haoxuan Chen, Muchuan Niu, Qiao Yu, Michael Jerrett, Yifang Zhu, *University of California, Los Angeles*

The 2025 Los Angeles urban wildfires released complex mixtures of metals, modifying the elemental composition of both airborne particles and surface dust. The magnitude of metal enrichment in airborne particles and surface dust remains poorly characterized. This study aims to compare metal enrichment in airborne particles versus surface dust and to provide mechanistic insights into the different metal enrichment patterns.

We collected 21 paired samples of fine particulate matter ($PM_{2.5}$) and co-located surface dust across households impacted by the 2025 LA fires between January 8 and February 18, 2025. Concentrations of 12 target metals were measured in both $PM_{2.5}$ and dust samples, and their respective mass fractions were calculated. To quantify differences in metal enrichment across media, we defined a cross-media enrichment factor for each metal as the ratio of its mass fraction in $PM_{2.5}$ to that in the paired dust sample.

Cd, **Li**, **Pb**, and **Zn** showed greater relative enrichment in $PM_{2.5}$ than in surface dust, whereas the opposite pattern was observed for **Co** and **Fe**. Importantly, this differential metal enrichment was strongly associated with thermal stability, as indicated by a significant inverse correlation between the metals' $PM_{2.5}$-to-dust enrichment factors and their melting points (Spearman's $\rho=-0.81$, p-value=0.0026). For example, **Cd**, with a relatively low melting point (594 K), had a $PM_{2.5}$-to-dust enrichment factor of 61, while **Fe**, with a much higher melting point (1811 K), showed a factor of only 0.35.

Our findings demonstrate distinct patterns of metal enrichment in $PM_{2.5}$ compared with surface dust and provide mechanistic insights into the physicochemical processes driving this behavior. This understanding can help inform future policies by supporting the development of metal-specific guidelines that differentiate between inhalation exposure and surface-contact exposure in wildfire-impacted environments.

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9WF.5

Developing and Evaluating a Wildfire Smoke Mitigation Plan to Protect Indoor Air Quality on a University Campus. FIONA HOPEWELL, Tristalee Mangin, Kerry Kelly, Sean Nielson, *University of Utah*

Poor indoor air quality (IAQ) is associated with numerous adverse human health effects. Yet, it has been less frequently studied than outdoor air quality. We have been operating a 21-node IAQ network since 2023, and initial findings suggest that wildfire smoke infiltration occurs more frequently in buildings with air-side economizers. Air-side economizers are an energy saving HVAC mechanism that opens an outdoor air damper during cool ambient temperatures to replace mechanical cooling. This study aims to understand the impact of wildfire smoke on indoor $PM_{2.5}$ and CO_2 concentrations, and it focuses on a pilot program involving two University of Utah buildings with air-side economizers and MERV 8 filters during the summers of 2025 and 2026 (roughly May 15 to September 31). One of the buildings served as a control that operated normally over the study period. The other building served as the experimental building where we were able to minimize the damper position of the airside economizer during wildfire smoke events. Preliminary results show that indoor $PM_{2.5}$ concentrations are significantly lower in the experimental building than in the control building; however, there was only one wildfire smoke event during the summer of 2025. The summer of 2026 will allow further evaluation of the effectiveness of our smoke mitigation plan.

9WF.7

Improved Representation of Wildfire Emitted Aerosol Precursors in the CAMx Model. KATIE TUITE, Jeremiah Johnson, Pradeepa Vennam, Haofan Li, Greg Yarwood, *Ramboll*

Wildfires are an important source of volatile organic compounds (VOCs) that act as precursors for secondary organic aerosols (SOA). As fires become an increasing air quality concern, it is important to accurately capture the chemistry of smoke plumes in air quality models. Condensed chemical mechanisms are used to efficiently represent photochemistry in atmospheric models but many mechanisms poorly represent VOC speciation of wildfire emissions. Here, we present recent updates to the CAMx regional air quality model to better represent SOA production from wildfire-emitted VOCs. We introduced a new lumped VOC species that collectively represents important SOA precursors such as phenols and furans. The new species was integrated in CAMx's gas-phase and aerosol chemistry schemes and tested for a smoke-impacted period in the Western U.S. during summer 2022. We conducted model runs with and without these updates and assessed model performance by comparing modeled PM2.5 concentrations against measurements from available monitoring stations. We also used CAMx's particulate source apportionment tool to assess the contribution of fire emissions to total PM2.5 concentrations at smoke-impacted sites. These CAMx updates can improve the model's ability to predict PM2.5 impacts from wildfires, strengthening its applicability for regulatory modeling, including State Implementation Plan development and Exceptional Event Demonstrations.

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9WF.8

Laboratory Investigation of the Physicochemical Properties of Aerosols from Wildland-Urban Interface Fires. XUANYU HAN, Shang Liu, *Northeastern University*

The expansion of the Wildland-Urban Interface (WUI) has significantly increased the frequency of fires that transition from natural landscapes into built environments. WUI fires include simultaneous combustion of natural biomass and human-made synthetic materials, resulting in complex emissions with physicochemical properties that are different from pure wildland fire smoke. Despite their increasing prevalence, data on WUI-specific emissions remain sparse.

In this study, we conducted a series of laboratory-controlled combustion experiments to characterize the emissions of representative WUI fuels including maple wood, polyvinyl chloride (PVC), oriented strand board (OSB), drywall, polystyrene foam, and polyester carpet. Individual fuels were combusted in a tube furnace under fuel-lean conditions across a range of temperatures to simulate different fire intensities and phases. Real-time aerosol characterization was performed using a High-Resolution Time-of-Flight Aerosol Mass Spectrometer (HR-ToF-AMS) for chemical composition and a Scanning Mobility Particle Sizer (SMPS) for size distributions. Offline analysis was conducted using Fourier Transform Infrared (FTIR) spectroscopy. We will analyze the evolution of aerosol mass spectra, composition, oxidation states, and size distribution as a function of combustion temperature and Modified Combustion Efficiency (MCE). In addition to individual fuel characterization, we will conduct burn experiments on fuel mixtures to examine the additivity of emission properties. These results will help improve our understanding of the unique chemical and physical signatures of WUI fires, which will aid in the source apportionment and health-impact assessment of WUI fire smokes.

9WF.9

The Effects of Fuel-Bed Characteristics and Environmental Conditions in Wildland Fires on the Emissions of Heavy Metals. THOMAS CARROLL, Muhammad Abdurrahman, Michael Caraway, Nicholas Kusumo, Kruthika Kumar, Anita Anosike, Mike Lesiak, Mac A. Callaham, Joseph O'Brien, Kathryn Zimmerman, Rawad Saleh, *University of Georgia*

Toxic heavy metals accumulate in wildland fuels, via natural processes or pollution transport, and are emitted in aerosol particles during fires. However, the processes underlying their release during combustion and incorporation in aerosol particles is poorly understood. During the second Georgia Wildland-fire Simulation Experiment (G-WISE-2), we investigated how the variability in fuel-bed composition (whether the fuel bed consisted of surface fuels only or included a duff layer underneath the surface fuels) and environmental conditions (manifested as moisture content) affect combustion conditions, and consequently metals emissions. We quantified eleven metals using an inductively coupled plasma mass spectrometer (ICP-MS): Al, Cr, Fe, Mn, Ni, Cu, Zn, Sr, Sb, Ba, and Pb.

Less efficient combustion, associated with increased moisture content or inclusion of duff in the fuel bed, led to higher emission factors of particulate matter (PM). However, the relative abundance of all metals in the PM (i.e., g-metals/g-PM) was substantially higher in more efficient combustion, indicating different release mechanisms between metals and the PM matrix. By comparing the trends in PM and metals emissions factors at different combustion conditions, we demonstrate that there are two likely mechanisms for metals emissions during combustion: (1) distillation from the fuel along with the PM matrix and (2) volatilization followed by recondensation on PM. The latter mechanism is more prominent at higher temperatures (more efficient combustion) and increases more with temperature for metals with relatively low volatility (e.g. Al and Fe) compared to those with relatively high volatility (e.g. Pb and Sb).

Heavy metals can be major drivers of PM toxicity. Therefore, the increase in metals per unit mass PM associated with increasing combustion efficiency reported in this study provides potential explanation for previous reports that PM produced in more efficient (flaming) combustion is more toxic than that produced in less efficient (smoldering) combustion.

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9WF.11

Emission of VOCs from Painted Surfaces Exposed to Simulated Wildland-Urban Interface Fires and Evaluation of Cleaning Methods. JANA BUTMAN, Dustin Poppendieck, Michael Link, *National Institute of Standards and Technology*

Wildland-urban interface (WUI) fires can generate a complex mixture of smoke from the burning of mixed manufactured materials such as lumber and plastic, negatively affecting air quality in the short term. Even after the immediate threat of wildfire has been cleared, soot-covered surfaces continue to affect indoor air quality (IAQ) through the emission of volatile organic compounds (VOCs). Painted surfaces such as walls in homes or works of art can be visually compromised by a layer of soot and act as a reservoir of these VOCs, making them critical candidates for remediation. While surface removal of deposited soot can improve the appearance of painted surfaces and reduce these emissions, quantification and identification of VOCs before and after cleaning is necessary to assess the efficacy of cleaning techniques. Additional information regarding the time scale of these emissions can inform when a home with painted walls may be safe to return to, or when a work of art can safely be returned to storage without contaminating other works in a collection.

We investigate the effects on IAQ from painted surfaces affected by WUI fires by exposing painted canvas surfaces to mixed-fuel crib smoke simulating domestic fire conditions. These samples are placed in a small chamber for 20 h to144 h under conditions prescribed by the Bizot Green protocol for art storage, and representative of a typical indoor environment (40% RH, 23 °C, 1.9 h-1 of ventilation). We use online proton-transfer-reaction time-of-flight mass spectrometry (PTR-ToF-MS) to identify and quantify the off-gassed VOCs from the painted samples before exposure to mixed-material crib smoke, following soot deposition, and post-cleaning using a hydrogel. The deposited smoke related particles increased the emissions of some chemicals emitted from the paint. Cleaning the soot-covered paint had small impact on the emission of those same chemicals.

9WF.12

Photochemical Aging Effects on Environmentally Persistent Free Radicals and the Oxidative Potential of Plastic Combustion Particulate Matter. BRADLEY H. ISENOR, Katerina Sajeniouk, Hongru Shen, Jonathan Abbatt, Arthur W. H. Chan, *University of Toronto*

Wildfires at the wildland urban interface (WUI) are becoming an increasingly important source of fine particulate matter ($PM_{2.5}$) globally. Smoke from WUI fires differs in composition compared to smoke from wildland fires due to the considerable amounts of anthropogenic materials found at the WUI, such as plastics. Recent studies have demonstrated that freshly emitted plastic combustion particles exhibited elevated levels of environmentally persistent free radicals (EPFR) and high oxidative potential, suggesting a strong capacity for these particles to induce oxidative stress. In practice, however, populations are often exposed to smoke downwind of wildfires, allowing the smoke to be photochemically aged as it is transported, modifying the composition of the $PM_{2.5}$ and potentially its EPFRs and oxidative potential. Despite this, the photochemical transformation of plastic combustion $PM_{2.5}$ and its effect on EPFRs and oxidative potential have yet to be characterized. To address this gap, we investigate how simulated atmospheric aging, through UV irradiation and exposure to principal daytime oxidants ($^{\cdot}OH$ and O_3), modifies the oxidative potential and EPFR characteristics of lab-generated $PM_{2.5}$ from the combustion of common plastics. The oxidative potential of $PM_{2.5}$ samples is measured using the dithiothreitol assay while EPFR content is quantified and characterized using electron paramagnetic resonance spectroscopy. Given the increasing frequency of WUI fires and the abundance of anthropogenic materials in these areas, characterizing how the toxicity of plastic combustion $PM_{2.5}$ evolves during transport is essential for understanding the health risks associated with WUI fire smoke exposure.

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9WF.13

The Emissions of a Burning Modern Home: An In-Depth Look at Emission Profiles from Southern California's Most Common Building Materials When Simulating an Urban Fire.

HOVANNESS DINGILIAN, Kainoa Koffman, Thomas Eckel, David R. Cocker, *University of California, Riverside*

In early 2025, the Eaton Canyon and Pacific Palisades Fires occurred in Los Angeles, California. These fires are the second and third most destructive fires in California's history with 9,413 and 6,833 structures burned respectively. With these fires came a variety of emissions from a multitude of sources. In this study, we aimed to understand the potential sources of structural fire smoke and what their unique emission profiles look like and how that can correlate to the health of surrounding communities and first responders. Furthermore, we looked into understanding how modern materials transform into smoke and ash when burned. The materials were divided into four categories; structure, exterior, interior, and contents. The materials in these categories include untreated lumber, pressure treated lumber, press wood, asphalt roofing, polyurethane foam, artificial turf, carpet, and electronics. These materials were burned in a 4 x 4 x 8 ft tall burn chamber with analysis run on the material before and after being burned. Sampling systems set up to capture the smoke collected data on both particulate and gaseous phase aerosol with some of the highlights centered around varying elemental carbon to organic carbon ratio, diverse metals, assorted carbonyl groups in some materials over others as well as real time gaseous emissions differences indicating differences in how these materials burn. This data can be used to enhance our understanding of the Urban portion of the Wildland-Urban Interface by developing detailed emission profiles for the most common materials found in every home.

9WF.14

RADSENSE: A Machine Learning-Based Smoke Forecast System.

ZONGRUN LI, Eric Wendt, Shantanu Jathar, Jesse Burkhardt, Ander Wilson, Christian L'Orange, John Volckens, *Colorado State University*

Wildland fires have increased substantially in recent decades and have become a major source of $PM_{2.5}$ pollution in the United States. Smoke from these fires can travel long distances, affecting large populations downwind and causing severe respiratory and cardiovascular health impacts. Accurate and timely smoke forecasts are therefore critical for public health protection and emergency response. However, current operational smoke forecasting systems rely primarily on physics-based numerical models, which have uncertainties in plume height, emission time profiles, and emission intensity, leading to inaccurate near-surface smoke concentration predictions and limiting their usefulness for real-time decision-making.

In this study, we develop a machine learning (ML) based ensemble framework to improve operational smoke forecasts by correcting biases in the Unified Forecast System-Air Quality Model (UFS-AQM), a chemical transport model forecasting system operated by the National Oceanic and Atmospheric Administration (NOAA). Our ML framework integrates multiple data sources, including satellite-derived aerosol optical depth, meteorological forecasts, regulatory air quality monitoring data, and low-cost sensor observations, to bias-correct UFS-AQM forecasts. Three ML models, XGBoost, LightGBM, and CatBoost, are trained using an out-of-fold learning strategy and combined using optimized ensemble weights to generate improved hourly $PM_{2.5}$ forecasts up to 24 hours in advance. We evaluated the ML model's performance by comparing it with UFS-AQM. The ML ensemble framework substantially improved forecast accuracy, with R^2 values ranging from 0.76 to 0.42 across lead times from 1 to 24 hours, compared with R^2 values below 0.16 for the UFS-AQM forecasts. The ML model performance generally decreased as lead time increased, while the UFS-AQM forecasts showed consistently poor performance, particularly during nighttime. The ML model also produced more accurate air quality index (AQI) predictions than UFS-AQM, although both models produced false negatives for hazardous air quality days. We also conducted SHAP analysis to improve model interpretability, which showed that historical observations played an important role at short lead times, whereas UFS-AQM forecasts became more important at longer lead times. In addition to improved performance, the ML framework remained computationally efficient, reproduced the spatiotemporal patterns of $PM_{2.5}$, and provided probabilistic estimates of prediction uncertainty. This approach can be operationalized into same-day forecasting systems, with the potential to provide timely and reliable smoke alerts to the federal and state air quality agencies, public health organizations, and vulnerable populations.

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9WF.15

Impact of Fuel Type and Combustion Phase on the Optical Properties of Wildfire Particulate Matter. Mahsa Zarei, Alireza Moallemi, Timothy Sipkens, Joel Corbin, JASON S. OLFERT, BBCan Team, *Department of Mechanical Engineering, University of Alberta*

Wildfires release substantial amounts of particulate matter (PM) into the atmosphere, significantly impacting air quality, human health, and climate. The optical properties of smoke particles determine how aerosols interact with solar radiation through light absorption and scattering, making them essential for accurate representation of wildfire emissions in atmospheric and climate models.

The optical properties of wildfire smoke vary significantly depending on fuel type and combustion phase. However, current climate models rely on global averages, which may not accurately capture the characteristics of fuels typical of boreal forests, where most Canadian wildfire activity occurs.

Building on the 2024 BBCan Fire Lab Campaign in Edmonton, this study measured the optical properties of smoke from controlled combustion of common boreal forest fuels under both flaming and smoldering phases. Fuels included grass, mulch, ponderosa pine, and peat, which exhibit distinct combustion behaviors affecting smoke properties. Measurements were performed at three wavelengths using a dual-spot aethalometer, Photoacoustic Extinctiometers (PAX), and Cavity Attenuated Phase Shift (CAPS) spectrometers.

The analysis focused on key parameters including the absorption coefficient, scattering coefficient, and single scattering albedo (SSA). Measurements indicate that flaming combustion generally produces higher light absorption associated with black carbon; while smoldering combustion tends to generate organic-rich aerosols that scatter light more efficiently. Additional comparisons between denuded and undenuded aerosol samples reveal the influence of particle coatings on measured optical properties.

This comprehensive dataset enables calculation of derived optical parameters, including the mass absorption coefficient (MAC), Angstrom exponent (AE), absorption cross-section, and scattering cross-section. Such data are critical for improving climate models, air quality predictions, and understanding the evolving impact of wildfire emissions on the atmosphere.

9WF.16

Indoor PM Instrument Performance During Surrogate Wildland-Urban Interface Fire Smoke Events. NATHAN LIMA, Aika Davis, Michael Link, Thomas Cleary, Ryan Falkenstein-Smith, Rileigh Robertson, Steven Emmerich, Dustin Poppendieck, *National Institute of Standards and Technology*

Wildland-urban interface (WUI) fires can significantly increase indoor particulate matter (PM) concentrations beyond established air quality benchmarks. However, most instruments used in WUI exposure research are calibrated and validated only for ambient outdoor concentrations and/or with inorganic aerosols or pure biomass smoke conditions. The Eaton and Palisades fires in Los Angeles in 2025, which affected thousands of homes, highlight the urgent need to understand how the instruments typically used to assess indoor exposure during WUI fires perform at the high indoor concentrations encountered during these events.

To address this, we deployed five different PM measurement instruments in the National Institute of Standards and Technology indoor air quality test house during 10 surrogate WUI fire smoke events. The peak concentrations measured during these events ranged from 220 $\mu g \cdot m^{-3}$ to 30,000 $\mu g \cdot m^{-3}$.

Throughout the study, we identified three concentration-dependent failure modes. One photometer-based instrument overestimated PM mass by a factor of 5 to 54 compared to all co-located instruments. This discrepancy was likely due to a mismatch between its calibration for mineral dust and the optical properties of mixed biomass and synthetic-material smoke found in WUI fire smoke. Additionally, all optical particle counters' channels exhibited unusual decreases in their finest size bins at peak concentrations, likely due to undersizing and/or optical coincidence. At the same time, the mobility-based scanning mobility particle sizer did not show these decreases in the overlapping size range. Furthermore, the cloud-based quality-control pipeline of the one instrument removed peak data that exceeded undocumented thresholds.

For indoor exposure assessments during WUI fires, PM mass values from co-located instruments can differ by factors greater than 50, and correction factors for biomass smoke do not apply to mixed-material WUI smoke. This has important implications for assessing occupant exposure, evaluating air cleaners, and developing community sensor networks.

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9WF.17

Size-Resolved Filtration Efficiency of Wildfire Smoke Surrogate Aerosols by HVAC Filters in a Full-Scale Duct Test Rig. XIAOSU DING, Jalil Mokhtarian Mobarakeh, Benjamin Kokaly, Caleb Rismiller, Meghan Megowan, Parichehr Salimifard, *Oregon State University*

Wildfire smoke is a major episodic source of indoor particle exposure, yet the size-resolved performance of HVAC filters for smoke aerosols remains insufficiently characterized. This study presents a full-scale duct test rig designed to evaluate the filtration of wildfire smoke surrogate aerosols by common HVAC filters under controlled laboratory operation. A smoke-generation chamber was integrated with the duct system to introduce smoke-gun-generated surrogate aerosols upstream of the test section. Particle size distributions upstream and downstream of the filters were measured using a scanning mobility particle sizer (SMPS), an aerodynamic particle sizer (APS), and an optical particle sizer (OPS), enabling characterization of filtration behavior from ultrafine to coarse particle sizes (10 nm-20 μm).

Our study compared a baseline MERV 8 filter with a higher-efficiency MERV 13 filter commonly recommended for wildfire smoke exposure mitigation. Each filter performance was quantified with size-resolved removal efficiency, pressure drop and associated clean air delivery rate (CADR) under controlled laboratory conditions. The primary objective is to evaluate smoke-like aerosol filtration by common HVAC filters in a full-scale ducted system and to generate an initial comparative dataset for baseline and higher-efficiency filtration.

This work is intended to improve understanding of the link between aerosol size distribution, filter characteristics, and actual smoke removal in HVAC applications. More broadly, this study provides an experimental basis for future investigation of air filtration performance as one of building-related smoke mitigation strategies.

9WF.18

Pushing the Limits of PM2.5 Removal by the Corsi-Rosenthal Box: From Necessity-Driven Filtration Materials to Extreme Clean Air Delivery Rates. ANTONIO BARATTA, Taewon Han, Gediminas Mainelis, *Rutgers, The State University of New Jersey*

The Corsi-Rosenthal (C-R) Box has been proven to be a highly effective, low-cost do-it-yourself (DIY) air cleaner for reducing indoor PM2.5 concentrations. Recent studies, including ours, systematically investigated how filter rating, electret enhancement, and measurement methodology affect C-R Box's clean air delivery rate (CADR), establishing a performance baseline for the standard designs. Building on these findings, the present study explores the two opposing extremes of the C-R Box design: maximizing CADR through thicker filters, more powerful fans, and a new C-R Box design versus necessity-driven filtration materials that could be used in environmental emergencies, such as PM2.5 intrusion from wildfires. We tested the C-R Box models with 4-and 5-inch filters, a stronger Vornado box fan, a 6-filter (hexagonal) design, and with blankets, pillowcases, and other common household items could be used as filtration materials. Furthermore, a cost analysis was conducted for all the options considered. These designs were challenged with aerosolized sodium chloride (NaCl) or Arizona Road Dust (ARD), and performance was determined as PM2.5- based CADR. There was a substantial performance improvement using 4-Inch MERV-13 filters, resulting in a CADR of 607 ± 5 cfm when air was moved using a standard box fan. The CADR of this configuration increased to 701 ± 20 cfm when using the Vornado box fan. The highest CADR of 760 ± 11 cfm was achieved with the same materials in a hexagonal air cleaner configuration. Alternatively, using blankets, pillowcases, and other common household items resulted in CADRs below 100 cfm. These findings demonstrate that certain modifications to the C-R Box design can substantially improve its performance. At the same time, using various household items to build a DIY air cleaner also provides some protection against PM2.5 exposure and can be used in emergencies, especially in dedicated areas, thereby providing public health benefits.

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9WF.19

Characterization of Gaseous and Particulate Speciated Organics Emitted from Laboratory-Scale Combustion of Structural Materials. MICHAEL MILAZZO, Bryce Bathras, Ting Wang, Mitchell Huffman, Robert Weber, Lindsay Yee, Nathan Kreisberg, Michael Gollner, Allen Goldstein, *University of California, Berkeley*

Wildland fires have become larger and more frequent in recent decades and have increasingly extended to the wildland-urban interface (WUI). Organic carbon emissions from biomass burning have been well characterized yet comparatively little is known about the chemical composition of organics emitted from burning structural materials. Exposure to these emissions may pose additional health concerns to WUI communities and others downwind, highlighting their importance for study. We combusted individual materials in a linear tube furnace to assess emission factors at two heat fluxes. We speciate the gas- and particle-phase organic emissions from combustion of structural materials using offline thermal desorption comprehensive two-dimensional gas chromatography with high-resolution time-of-flight mass spectrometry. We present emission factors relative to fuel mass, heat flux and modified combustion efficiency for specific structural materials.

Speciated organic emissions from burning lumber and processed woods show similar levels of complexity to biomass burning, which typically contain hundreds to thousands of unique chemicals. In contrast, speciated organic emissions from burning plastics show less chemical complexity than woody structural materials, with few compounds comprising a high mass fraction of the total signal. We observe compound classes such as phthalates, phthalic acids, glycol ethers, and alkanoic acids that suggest degradation of certain plastics into monomers and evidence of chemical additives, in addition to typical combustion products like PAHs. Potential chemical tracers for individual structural materials are proposed. We discuss our progress in creating custom mass spectral libraries for each structural material to aid in compound identification and tracking across experiments and in future studies.

Emission factors of speciated organics from combustion of structural materials will improve state and federal emission inventories of WUI fires, and will improve chemical transport models to assess WUI fire impacts on local and regional air quality.

9WF.20

Aerosol Optical Properties of Wildfire Smoke Transported to the Southern Great Plains of the U.S. HAYDEN WEBB, Sandra Marcela Loria Salazar, Connor Flynn, Jens Redemann, Hans Moosmüller, Kyle Eskew, *University of Oklahoma, School of Meteorology*

With climate change and wildland fuel buildup increasing the risk of wildfires, exposure to smoke is a growing health concern. Wildfires emit large quantities of combustion aerosols, which have intense local effects and can be transported thousands of miles downwind. While many U.S. field campaigns have studied smoke physical and chemical properties near the fires, changes of aerosol physical properties during long-range transport have been less examined. This is especially important as transport and aging effects on aerosol properties are not represented in many atmospheric models. Our investigation aims to improve the understanding of smoke aerosol physical properties, including aerosol optical depth (AOD), extinction Ångström exponent (EAE), single scattering albedo (SSA), and absorption Ångström exponent (AAE) in the Southern Great Plains, specifically in Oklahoma. A total of twenty-seven cloud-free smoke events between 2015 and 2022 were identified using a combination of MODIS Deep Blue AOD maps, AERONET ground station data, and HYSPLIT back-trajectories parameterized by plume heights determined from MicroPulse Lidar. Comparisons of AERONET observations across various sites revealed evidence of long-range transport, with AOD, EAE, and SSA decreasing and AAE increasing as the smoke was transported to the ARM SGP site near Billings, OK. Mean AOD decreased during transport by ~0.21, ~0.38, ~1.69, ~1.43, and ~0.1, while mean EAE decreased by ~0.14, ~0.2, ~0.24, ~0.17, and ~0.19 for zero (less than 24 hours) through four-day transport time, respectively. Mean SSA decreased by ~0.02, ~0.02, <0.01, ~0.02, and ~0.01, while mean AAE increased by ~1.26, ~0.16, ~0.04, ~0.34, and ~0.32 for zero through four-day transport time, respectively. While lower arrival height may be associated with shorter transport times, the underlying meteorology driving wind direction and speed seems to be the primary determinant of the plume path. Our findings highlight the need for further research to explore the impact of meteorological conditions and variations in fuel type on smoke aerosol optical properties and their evolution during transport.

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9WF.21

Size-Resolved Fine and Ultrafine Particle in an Older Educational Buildings: Effects of HVAC Operation and Meteorology. JIANING BAO, Nigel Kaye, Ehsan Mousavi, Andrew Metcalf, *Clemson University*

Older educational buildings often lack centralized mechanical ventilation and rely on decentralized HVAC systems, such as fan-coil units (FCUs). This configuration may increase occupant vulnerability to poor indoor air quality (IAQ) due to limited ventilation and filtration capabilities, especially during periods of high occupancy and polluted outdoor conditions such as wildfires. Fine and ultrafine particles dominate indoor and outdoor particle number concentrations, and their ability to deposit deep in the respiratory tract makes them especially relevant for occupant exposure.

This study characterizes size-resolved particle infiltration in a classroom inside a building built in 1958, equipped with two recirculating FCUs and operable windows. From August to December 2025, indoor and outdoor particle number size distributions were measured during unoccupied weekends and holidays using a Scanning Electrical Mobility Spectrometer alternated between indoor and outdoor inlets every five minutes. Measurements were conducted under three operating conditions: closed-window operation with FCUs running, natural ventilation with windows open, and closed-window infiltration with FCUs off. Air exchange rates were determined from CO_2 decay tests, and size-resolved indoor loss rates were quantified from controlled DOS aerosol releases under varying FCU operation. We examine how size distributions vary across diurnal and seasonal cycles, as well as size-dependent indoor-to-outdoor (I/O) number ratios across the three operating conditions. Cross-correlation analysis is used to quantify size-dependent time lags between outdoor and indoor concentrations, and a multiple linear regression links I/O ratios to meteorological predictors including wind components, temperature, relative humidity, and precipitation. A dynamic mass-balance model constrained by independently measured loss rates and air exchange rates estimates size-resolved penetration factors. Together, these results characterize how building operation and meteorology jointly influence fine and ultrafine particle infiltration in older educational buildings, informing mitigation strategies during wildfire smoke episodes and other elevated outdoor PM events.

9WF.22

Elevated Particulate Chloride from Infiltrated Wildland-Urban Interface Fire Smoke in Indoor PM_1. BENJAMIN WERDEN, Michael Link, Nathan Lima, Benjamin A. Nault, Aika Davis, Thomas Cleary, Ryan Falkenstein-Smith, Rileigh Robertson, Dustin Poppendieck, Peter F. DeCarlo, *Johns Hopkins University*

The frequency and intensity of wildland-urban interface (WUI) fires are increasing. WUI smoke has a chemical profile distinct from wildfires due to the combustion of household contents and synthetic building materials, including chlorinated polymers, alongside vegetation. Indoor infiltration of WUI smoke is a potential route of exposure. The indoor behavior of WUI smoke is poorly characterized, and few controlled experiments have resolved how source materials shape indoor composition in-situ.

We conducted a series of controlled burns at the NIST Indoor Environment and Ventilation Test House. Small-scale surrogate residential cribs were combusted outside the structure with the resulting smoke infiltrating the test house. Indoor PM_1 chemical composition was measured by aerosol mass spectrometer (AMS) with additional concentrations measurements for nine burns of varied filtration conditions.

The mean indoor PM_1 peaked around 350 $\mu g\ m^{-3}$ during burn periods, compared to a background of 0.33 $\mu g\ m^{-3}$. The measured chemical composition was chloride-rich; the chloride to organic aerosol ratio (Cl/OA) averaged 0.6. This is significantly higher than the 0.2 in controller laboratory burns of similar materials at Colorado State University. Chloride decayed faster than organic aerosol across burns, suggesting composition-dependent losses such as gas-phase repartitioning or uptake to indoor surfaces, with possible implications for HCl partitioning and indoor chemistry. Indoor WUI smoke is chemically distinct, with an inorganic chloride fraction that behaves differently from the organic fraction and is not captured by total PM mass.

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9WF.23

Population Exposure and Health Impacts of Prescribed Burns in California. RASHMI RAJPUT, Tong Zhang, Mohammad Astaneh, Kelley Barsanti, Sean Raffuse, Wenfu Tang, Michael Kleeman, *University of California, Davis*

With the increasing frequency and intensity of extreme wildfire events, effective interventions are essential to reduce air pollution exposure and associated health impacts. Prescribed burns have been introduced in California as one such intervention, however, they carry their own smoke-related risks. This study investigates the impact of prescribed burns on population exposure to $PM_{2.5}$, across California. Air quality simulations were performed for five years to represent high, median, and low wildfire conditions: 2010, 2012, 2016, 2018, and 2020. After confirming basecase model performance, prescribed burn scenarios were introduced into these historical simulations to evaluate impacts associated with reduced fuel loads. The resulting annual average $PM_{2.5}$ concentrations were used to estimate health impacts using EPA's BenMAP-CE v1.5 model. Mortality changes associated with prescribed burns and wildfires were quantified as a function of location within each fire year. Prescribed burns reduce overall health impacts in high wildfire years, with less certain benefits in median and low wildfire years. Mortality averaged across all years was reduced due to the adoption of prescribed burning, but the timing and location of the prescribed burns affected these results. Specifically, prescribed burns in the deep forest were found to be more beneficial than prescribed burns at the wildland urban interface across all fire years. The findings highlight the public health costs associated with prescribed burns and the need to carefully design prescribed burn programs to achieve maximum efficiency.

9WF.24

Machine-Learning Framework for Wildfire Plume Injection Height. MOHAMMAD ASTANEH, Rashmi Rajput, Tong Zhang, Kelley Barsanti, Wenfu Tang, Sean Raffuse, Michael Kleeman, *University of California, Davis*

Quantifying wildfire plume injection height is critical for constraining the vertical distribution of emissions and improving the predictive skill of chemical transport models (CTMs). Existing parameterization schemes, such as the Freitas and Briggs formulations, often exhibit systematic biases particularly within the surface layer (SL)-which can lead to biases in modeled pollutant concentrations near the source and in downwind regions. This study aims to develop a machine learning based bias correction framework that integrates multi-satellite plume observations from MISR and CALIPSO with meteorological and fire radiative power (FRP) data to better represent injection height variability. Neural network and ensemble methods (random forest, XGBoost) will be trained using satellite-derived plume heights as targets and meteorological and fire-related variables as predictors. The bias-adjusted plume heights will then be used to modify the vertical allocation of fire emissions in a three-dimensional CTM to evaluate how plume-rise representation influences modeled smoke transport and surface pollutant levels. This approach is expected to improve the physical realism of plume injection estimates and reduce plume-height-induced uncertainties in smoke modeling and air quality assessment.

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9WF.25

Oxidant Generation by Chamber-Aged Smoke Particles Sampled Directly Into Simulated Lung Fluid. EVELYN YANDLE, David De Haan, *University of San Diego*

Smoke from biomass burning / wildfires is more hazardous to human health than other types of PM2.5 These health hazards can be estimated in lab experiments by quantifying the reactive oxidant species generated by the aerosol as they enter the epithelial lining fluid (ELF). Recent work indicates, however, that ~95% of the oxidant generation capability of smoke aerosol is lost during the filtration and extraction process. To capture the full spectrum of short- and long-lived ROS-generating species in smoke, the smoke must be sampled directly into simulated lung fluid, bypassing filtration and extraction. Here we report on lab simulations of smoke aerosol ROS generation using a particle-into-liquid sampler (PILS) to transfer smoke directly from the CESAM chamber into simulated ELF. Smoke particles were generated by smoldering peat and palm biomass samples in a 400C tube furnace, and aged for 1.5 h using ozone, sunlight, or OH under wet and dry conditions, and NO3 radicals under dry conditions. Total oxidant production by fresh and aged smoke was quantified by terephthalic acid losses using HPLC. Our results indicate that ROS generation in ELF by smoldering smoke particles increased under both OH and O3 oxidation conditions, with substantially greater ELF oxidant generation after aging in wet compared to dry environments. Light exposure enhanced ELF oxidant generation under wet environments but reduced signals under dry environments. In contrast, NO3 radical exposure generally suppressed ELF oxidant generation. By comparison to parallel filter-based experiments, we conclude that ELF oxidant generation by smoke aerosol aged under wet conditions and sampled directly into ELF is due primarily to short-lived species that do not survive filtration and extraction protocols.

9WF.27

Wildfire Smoke-Induced Charge Degradation in Residential Electret HVAC Filters. SHIBO WANG, Qisheng Ou, Xiaoliang Wang, Zhengyuan Pan, Dongryul Park, Keonwang Lee, Hyungho Park, Francisco Romay, David Y. H. Pui, *University of Minnesota*

Wildfire smoke poses an increasingly significant and recurrent threat to indoor air quality as fire frequency and intensity rise; however, the performance and effective lifetime of residential HVAC filters under sustained wildfire smoke exposure remain poorly understood. Most existing knowledge derives from standardized filtration tests using idealized aerosols that do not capture the complex composition and physicochemical properties of wildfire smoke or its interactions with electret media. Here, we show that wildfire smoke degrades electret filter performance through mechanisms fundamentally distinct from those represented in conventional testing. Combining laboratory-generated flaming and smoldering wood smoke, field sampling during prescribed burns, and controlled soot-particle challenges, we isolate the roles of particle composition and loading dynamics. Filtration efficiency collapses at particle loadings far below those associated with appreciable pressure-drop increases, revealing a strong decoupling between removal efficiency and airflow resistance. This behavior is primarily driven by soot-rich particles, which induce rapid, largely irreversible neutralization of electret charge within filter fibers, rather than by progressive mechanical clogging or by organic aerosol deposition alone. As a result, filters may maintain acceptable airflow while losing substantial electrostatic capture efficiency, causing pressure-based replacement criteria to overestimate usable filter lifetime during wildfire smoke events. Incorporating these experimentally constrained degradation pathways into a dynamic indoor air model shows that effective filter lifetime during wildfire episodes can decline from months to days, even under moderate outdoor concentrations. Model results further indicate strong sensitivity to building air exchange rates, HVAC operation, and filter characteristics, leading to substantial variability in indoor protection. Application of U.S. EPA monitoring data to a regional wildfire episode confirms that indoor exposure reduction can deteriorate rapidly once electret charge decay begins. Together, these findings identify soot-driven electret charge neutralization as a critical vulnerability of residential HVAC filters and reframe wildfire smoke filtration as primarily constrained by charge stability rather than pressure–drop–driven loading, with implications for testing standards and replacement guidance during smoke events.

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9WF.28

Integrated Hygroscopic Growth and Bounce Fraction Measurements of Smoke Aerosol Before and After Oxidative Aging. SLATER RUBIO-WILLIAMS, Stella Osman, Samantha Ortiz-Naranjo, Gavin Emerzian, David De Haan, *University of San Diego*

Biomass burning produces large emissions of CO2 and light-absorbing particles. Such particles pose significant negative impacts on human health, climate, and the ecosystem, some of which also depend on interactions with water. Studies show that chronic exposure to wood and biomass smoke particulate matter, especially ≤2.5 micrometers is linked to exacerbation of respiratory illnesses such as asthma and COPD, along with being a cause of premature death. Hygroscopicity is key to understanding how these particles change in size and mass due to water absorption. Many factors can influence smoke particles' hygroscopicity like chemical aging, exposure to sunlight, and interactions within clouds. Primary and secondary particles from biomass burning can also exist in a solid, liquid, or semi-solid state due to their different viscosities. These different phase-states can directly influence how quickly they equilibrate with the surroundings. However, the chemical makeup of biomass burning aerosol is also highly dependent on the fuel type and burning conditions, which influence hygroscopicity and viscosity. In this study, a Hygroscopic Growth and Bounce (HGAB) instrument was built to simultaneously measure particle growth and bounce fraction when exposed to changing relative humidity levels. Particle growth indicates their water-uptake ability and particle bounce indicates their phase state. A series of characterization experiments were conducted using atomized ammonium sulfate and other salt particles. This study primarily investigated the original or aged smoke aerosol produced by pine, eucalyptus, live oak, and palm biomass, heated to 400ºC simulating the smoldering processes. Preliminary results indicate changes in water uptake and particle bounce for the differing biomasses, but follow general trends of gradual water uptake as RH increases from 25% to 70%, and accelerating above 70%, except for palm smoke. Particle bounce declined to a minimum value, however, by the time RH reaches 65%. Smoke oxidation via ozone, OH radicals, or sunlight exposure exhibited different effects on hygroscopicity and bounce. Trends by oxidant and biomass type will be summarized.

9WF.29

Assessing Indoor Versus Outdoor PM2.5 Concentrations During the 2025 Los Angeles Fires Using the PurpleAir Sensor Network. YAN LU, Xinyi Zhang, Soroush Neyestani, Ling Jin, Lu Zhang, Rima Habre, Jiachen Zhang, *University of Southern California*

In January 2025, a series of fast-moving wildland-urban-interface (WUI) fires swept through the Los Angeles (LA) metropolitan area, causing severe air pollution. While the impacts of WUI fires on outdoor air quality have been extensively studied, indoor exposure remains less understood, despite most people sheltering indoors during WUI fires. This study investigates the spatial and temporal patterns of indoor and outdoor $PM_{2.5}$ concentrations across the South Coast Air Basin, with a focus on LA County during the LA fires. Using high-resolution data from co-located indoor and outdoor PurpleAir (PA) sensors, we analyze hourly $PM_{2.5}$ levels and indoor/outdoor ratios. Outdoor $PM_{2.5}$ concentrations spiked sharply during the fires, reaching unhealthy levels exceeding 130 $\mu g/m^3$, compared to the mean concentration (12 $\mu g/m^3$) during non-fire hours. Indoor concentrations also increased, though to a lesser extent, peaking around 60 $\mu g/m^3$ compared to a mean of 7 $\mu g/m^3$ during non-fire hours. This reflects the partial shielding that indoor environments provide from outdoor air pollution. The mean (0.42) and median (0.29) indoor/outdoor $PM_{2.5}$ ratios during LA fire hours were lower than the mean (0.93) and median (0.66) ratios during non-fire hours. Indoor/outdoor $PM_{2.5}$ ratios across sensors showed a wide distribution, reflecting differences in building characteristics and occupant behavior, such as indoor activities and the use of air purifiers. These findings emphasize the need for guidance and interventions to reduce indoor $PM_{2.5}$ exposure and protect public health during extreme WUI fire events.

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9WF.30

Indoor Exposure to Smoke-Derived PM2.5 During Prescribed Burning Events. SHABNA VALIYAKATH, John Bowman, Satya Patra, *University of Alabama*

Prescribed burning is an essential land management practice for mitigating wildfire risk. However, prescribed burns inherently emit fine particulate matter ($PM_{2.5}$), which can undergo atmospheric transport, disperse regionally, and eventually infiltrate indoor environments. During prescribed burns, occupants are typically advised to remain indoors under the assumption that buildings provide adequate protection against smoke exposure. To evaluate this assumption, a week-long field measurement campaign was conducted in an office environment at the University of Alabama, Tuscaloosa, approximately 26 miles from a prescribed burn site. Indoor particle concentrations were measured using an optical particle counter and a condensation particle counter, while outdoor $PM_{2.5}$ data were obtained from a U.S. EPA monitoring site. $PM_{2.5}$ mass concentrations were derived using a gravimetric correction factor. During prescribed burning events, outdoor $PM_{2.5}$ concentrations at the downwind monitoring site reached up to 78 µg m^{-3}. Concurrently, the monitored indoor space, served by an HVAC system equipped with a MERV-10 filter, experienced substantial infiltration of smoke-derived $PM_{2.5}$, with indoor concentrations reaching as high as 44 µg m^{-3}. This infiltration was attributed to the low filtration efficiency of MERV-10 filters for particles in the 0.3-0.5 µm size range, which corresponded to the mass mode of $PM_{2.5}$ during the prescribed burning events. Therefore, MERV-10 filters provide inadequate protection against smoke exposure during prescribed burns. Modeling results further suggest that upgrading from MERV-10 to MERV-13 filtration could reduce exposure by an additional 59% relative to the MERV-10 case. Alternatively, operating a 200 CFM air purifier in the space could reduce exposure by an additional 66% relative to the MERV-10 case. Collectively, these results demonstrate that improved filtration or supplemental air purification is needed to better protect building occupants from smoke exposure during prescribed burning events.

9WF.32

Total Fluorine and Chlorine in Particulate Emissions from Battery Fires with Varied Ignition Sources. AUDREY TOMBAUGH, Ryan Falkenstein-Smith, Aika Davis, Thomas Cleary, *National Institute of Standards and Technology*

Lithium-ion battery fires produce complex emissions that include toxic gases and particulate matter, yet the halogen composition of the particulate phase remains poorly characterized. To characterize this, four types of fully charged lithium-ion batteries – LiFePO4 prismatic battery, 18650 cylinders, and both 3- and 6-cell lithium polymer pouches – were subjected to two trigger mechanisms to induce thermal runaway. These mechanisms included exposure to a 25 ± 5 kW natural gas fire and a pneumatically driven puncture to the battery side wall. Smoke generated during tests was drawn through a 0.5 MW calorimeter hood at the NIST National Fire Research Laboratory, where particulate matter was collected onto quartz filters. The concentrations of fluorine and chlorine in the particulates captured by these filters were quantified via combustion ion chromatography (CIC), in which a portion of each filter was combusted and the combustion products underwent pyrohydrolysis before IC analysis. These results provide insight into how the fluorine and chlorine content of battery fire particulates vary among battery chemistries and thermal runaway induction mechanisms.

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9WF.33

Urban Wildfires Generate Pervasive and Persistent Metal Aerosol Pollution. DOUGLAS HAMILTON, Haroula D. Baliaka, Dante Capone, Peter Morton, Nga Lee Ng, Elisa Bergas-Masso, Rasmus Swalethorp, Richard Flagan, Julie Dinasquet, *North Carolina State University*

The January 2025 Los Angeles wildfire outbreak, including the Palisades, Eaton, and Hughes fires, burned across one of the world's largest metropolitan regions, exposing millions of people to an unprecedented episode of wildland–urban interface (WUI) smoke. Unlike vegetation fires, urban wildfires mobilize a complex mixture of metals originating from buildings, vehicles, infrastructure, and household materials, releasing both toxic and previously underappreciated aerosol constituents with implications for air quality, human health, and aquatic ecosystems. Here we present observations of aerosol metal concentrations collected across the Los Angeles metropolitan region throughout the fire event and recovery period. We quantify the magnitude, composition, and persistence of metal pollution associated with the fires and evaluate its spatial and temporal extent. Our measurements reveal that elevated aerosol metal concentrations were not confined to the immediate fire perimeter but were pervasive across the Los Angeles metropolitan region and the adjacent coastal waters, demonstrating widespread transport of combustion-derived metals far beyond the burn areas. Enhanced concentrations persisted well beyond the active burning phase, with elevated metal loadings observed even after the fires reached 100% containment. These findings demonstrate that urban wildfires can generate extensive, persistent, and regionally significant metal aerosol pollution. The prolonged enhancement in aerosol metals after fire containment challenges the common perception that air quality rapidly recovers once fires are controlled and highlights the critical importance of sustained, long-term atmospheric measurements for accurately characterizing exposure, informing public health responses, and understanding the full environmental legacy of urban wildfire disasters.

9WF.34

Ozone Aging Enhances the Hygroscopicity and Cloud-Forming Potential of Wildfire-Derived Phenolic Acid Aerosols. Minh Tran, Em Nortmann, Rayhanna Harper, Alexander Georgiev, DENISIA POPOLAN-VAIDA, *University of Central Florida*

Wildfires are an increasingly important source of atmospheric particulate matter, emitting large quantities of organic aerosols that influence air quality, cloud formation, and climate. Among the compounds released during biomass burning, phenolic acids derived from lignin degradation are important constituents of biomass-burning organic aerosol and potential brown carbon precursors. During atmospheric transport, these species undergo oxidative aging through reactions with atmospheric oxidants such as ozone (O_3), altering their physicochemical properties and aerosol–cloud interactions.

Here, we investigate the effects of heterogeneous O_3 oxidation on the hygroscopicity of four atmospherically relevant phenolic acids: vanillic, syringic, ferulic, and gallic acids. Fresh particles exhibited markedly different hygroscopicity parameters (κ), following the order gallic acid > ferulic acid > syringic acid > vanillic acid, indicating that particle water uptake depends on both oxygenated functional groups and broader molecular structural characteristics.

Reactive uptake coefficients for heterogeneous O_3 oxidation of the investigated phenolic acids ranged from 2.0×10^{-7} to 5.2×10^{-7}, indicating relatively slow ozone uptake. Despite modest differences in reactivity, O_3 aging increased the hygroscopicity parameter κ for all systems, indicating enhanced hygroscopicity and cloud droplet activation potential. Vanillic acid exhibited the lowest uptake coefficient (2.0×10^{-7}) but the largest relative increase in κ (0.00035–0.002). Ferulic and syringic acids displayed similar uptake coefficients (3.23×10^{-7} and 3.27×10^{-7}), with κ increasing from 0.006 to 0.023 and from 0.004 to 0.018, respectively. Gallic acid exhibited the highest uptake coefficient (5.23×10^{-7}) and the largest absolute increase in κ, from 0.015 to 0.065.

The observed differences in hygroscopic response are consistent with the influence of molecular structure on oxidation chemistry and the properties of the resulting oxidation products. Importantly, increases in hygroscopicity did not scale directly with reactive uptake coefficients, indicating that cloud-relevant aerosol properties are not controlled solely by ozone uptake kinetics. Instead, the hygroscopic response appears to depend on the chemical nature of the oxidation products formed during aging.

Overall, O_3 aging significantly enhanced the hygroscopicity of wildfire-derived phenolic aerosols, with aged κ values for syringic, ferulic, and gallic acids approaching those reported for atmospheric organic aerosols. These results highlighting the importance of incorporating composition-dependent chemical aging processes into models of biomass-burning aerosol impacts on climate and aerosol–cloud interactions.

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9WF.35

Backward Lagrangian Modeling of WUI Fires: Evaluating PM Exposure and Emission Gaps in the LA Basin. ALOK KUMAR THAKUR, Kevin Ridgway, Ky Tanner, Colette Schissel, David T. Allen, Christian L'Orange, Shantanu Jathar, *Colorado State University*

Wildland-Urban Interface (WUI) areas contain nearly 50 million homes in the United States and continue to expand by approximately one million homes every three years. Smoke from WUI fires can substantially degrade air quality and increase the risk of illness and premature mortality. The current study evaluates the January 2025 Eaton and Palisades fires in Los Angeles by coupling a published emission inventory with the Stochastic Time-Inverted Lagrangian Transport (STILT) model to estimate ambient PM and CO concentrations. Primary PM and CO emissions, including contributions from burned vegetation, structural losses, and vehicle combustion, were rasterized onto a high-resolution grid of 0.005^{o} x 0.005^{o}. Receptor-specific atmospheric footprints were generated using STILT's backward Lagrangian framework, representing the upwind sensitivity of air parcels backtracked by 24-48 hours, arriving at each receptor. These footprints were convolved with gridded emissions to estimate PM and CO concentrations and evaluate combustion emissions, transport, and atmospheric dilution. Hourly simulations were conducted for ten receptor locations across the Los Angeles Basin during the active burn period in the second week of January 2025. Model predictions were evaluated against observations from United States Environmental Protection Agency (US-EPA) and South Coast Air Quality Management District (SCAQMD) monitoring stations. The model captured major smoke episodes observed at monitoring stations, with minor shifts in peak timing. Predicted PM concentrations consistently underestimated measured values, suggesting that the current emission inventory underestimates total emissions from WUI fires. Although PM mass is an important indicator of wildfire smoke exposure, chemically distinct emissions from vegetation and structural combustion may result in different health impacts despite similar PM levels. The STILT framework enables high-resolution receptor-specific wildfire smoke exposure assessment. Future work will incorporate Burning Homes And Structural MAterials (BHASMA) derived emission factors, refined fuel loading estimates, and improved emission mapping to predict chemically resolved PM components and VOCs.

9WF.36

Characterizing Functional Group Evolution in Biomass Burning Organic Aerosols Using Delta Analysis. WILLOW HWANG, Janie (Yeaseul) Kim, Christopher Lim, Jesse Kroll, Christopher Cappa, Rachel O'Brien, *University of Michigan*

Biomass burning organic aerosol (BBOA) is a major contributor to atmospheric particulate matter that can influence air quality and climate. However, predicting the atmospheric impact remains challenging because the particles contain thousands of different organic compounds and are subject to photochemical aging processes. Previous studies suggest that these aging processes can change the composition of BBOA and thus the particles' behavior and interactions with the surrounding environment. Despite increasing wildfire emissions, the effect of atmospheric aging on the chemical evolution of BBOA is poorly understood. Aerosol Mass Spectrometry (AMS) provides insights into organic aerosol composition; however extensive electron-ionization fragmentation complicates direct determination of functional group distributions. In this study, we investigate changes in functional group distributions following aging experiments during the Fire Influence on Regional and Global Environments Experiment (FIREX) 2016. We use delta functional group analysis, which provides quantitative estimates of functional group fractions from high resolution AMS mass spectra. In FIREX, fresh emissions from multiple biomass fuels were subjected to controlled photochemical aging in an environmental chamber. The initial functional group distributions and the changes that occurred during aging are characterized across different burns to evaluate the effects of fuel type and combustion conditions. We also examine the AMS mass spectra of oxidized aromatic standards to gain context for assigning functional groups to certain delta values.The characterization of functional group distributions will improve our understanding of biomass burning organic aerosol aging and support more accurate predictions of the particles' atmospheric impact.

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9WF.37

Enhanced Radiative Cooling by Large Aerosol Particles from Pyrocumulonimbus. YAOWEI LI, John Dykema, David Peterson, Xu Feng, Xiaoli Shen, Nicole June, Michael Fromm, Theodore McHardy, Justin Jacquot, Jasna Pittman, Bruce Daube, Steven Wofsy, Jonathan Dean-Day, Anita Rapp, Kenneth Bowman, Daniel Cziczo, Loretta Mickley, Jeffrey R. Pierce, Frank Keutsch, *California Institute of Technology*

Intense wildfires can generate pyrocumulonimbus (pyroCb) clouds that transport substantial amounts of smoke into the upper troposphere and lower stratosphere (UT/LS), perturbing aerosol budget and physicochemical properties in these regions. Although pyroCb events are projected to become more frequent in a warming climate, their climate impacts—particularly the radiative forcing of pyroCb smoke aerosols—remains poorly constrained, primarily due to limited direct measurements. Here we present the first in situ aircraft measurements of 5-day-old pyroCb smoke, obtained during the NASA Dynamics and Chemistry of the Summer Stratosphere (DCOTSS) mission at altitudes of 14–15 km. These data fill a critical observational gap in pyroCb aerosol evolution, capturing the transition phase that was missing between the freshly emitted and the weeks-to-months-aged states reported in previous studies. The sampled smoke primarily contained unusually large aerosol particles (500–600 nm in diameter), likely formed through cloud processing and efficient coagulation in the UT/LS. Compared to smaller particles typically found in non-pyroCb smoke (200–300 nm in diameter), these large particles increase top-of-atmosphere instantaneous outgoing radiation by 30–36%, substantially enhancing atmospheric radiative cooling. Current climate models may greatly underestimate this cooling effect by assuming smaller aerosol sizes for pyroCb smoke. As pyroCb events become more frequent in the future, accurately representing their aerosol properties is essential for improving climate projections.

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10AC.1

Prebiotic Photochemistry in Aerosol Particles. THOMAS PRESTON, *McGill University*

Aerosol particles may have provided chemically distinct environments for prebiotic photochemistry in early Earth atmospheres by concentrating reactants, modifying reaction pathways, and enabling size- and humidity-dependent chemistry. Here, we use levitated particles as model atmospheric microreactors to investigate how droplet confinement, composition, relative humidity, and irradiation influence chemical transformations relevant to molecular complexity. Single-particle optical trapping and electrodynamic balance measurements are combined with Raman spectroscopy and mass spectrometry to follow changes in individual droplets without ensemble averaging. This approach enables direct measurements of size- and composition-dependent photochemical behaviour under controlled environmental conditions. The results provide insight into how aerosols could have influenced prebiotic reaction environments and contributed to chemical processing in the early atmosphere.

10AC.2

Exploring Prebiotic Aerosol Chemistry Using Single Particle Levitation. AARON M. PALMISANO, Stephanie Salas, Lorraine Rhovierose Rivera, James F. Davies, *University of California, Riverside*

Aerosols play a crucial role in atmospheric processes, affecting climate, air quality, human health, and planetary processes. Environmental factors, such as relative humidity (RH) and solar irradiation, influence aerosol behavior, driving changes in size, refractive index, hygroscopicity, phase states, and composition. On prebiotic Earth, the reducing atmosphere and UV-rich solar spectrum at the surface may have played a role in the chemical processes that led to the formation of life. In this work, we explore the application of single particle techniques to analyze aerosol particles and explore processes relevant to prebiotic Earth. Using a linear quadrupole electrodynamic balance (LQ-EDB) coupled with an open port sampling interface mass spectrometer (OPSI-MS), we measure the chemical and physical evolution of individual aerosol particles. Single aerosol particles are levitated in the LQ-EDB for an in-situ physical analysis, then deposited and solubilized in the OPSI and aspirated via electrospray ionization into an Orbitrap mass spectrometer for molecular characterization.

We simulate atmospheric aerosols derived from early ocean chemistry and naturally occurring prebiotic compounds. Initial work explored prebiotic sea spray aerosols (SSA), which exhibit unique water uptake and optical properties that influence light absorption, scattering, and aerosol photochemistry. These SSA may contain small molecules, such as simple amino acids, which may form the building blocks of peptides. Our earlier work using an aerosol optical tweezers showed that diglycine can form in particles containing glycine and dicyandiamide (DCD). In the EDB, the reaction is not observed until the samples are illuminated by UV light, with preliminary measurements showing diglycine formation at 250 nm. We further explore this reaction system in other prebiotic Earth environments to explore potential pathways for early peptide formation. By examining factors such as hygroscopicity and photochemical reactivity, we assess how aerosols may have facilitated peptide formation and contributed to the origin of life.

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10AC.3

Enhancement of Esterification Reaction Rates in Solvent-Free Aerosol Droplets. BRYAN R. BZDEK, Joshua Harrison, Aleksandra Marsh, Rachael E.H. Miles, Allen E. Haddrell, Jonathan P. Reid, *University of Bristol*

Aerosols are appealing vessels for accelerating chemical reactions owing to their high surface area-to-volume ratios and capacity to access supersaturated solute states. Although many studies demonstrate enhanced reaction rates in charged droplets using electrospray ionisation-mass spectrometry, such studies have poor control over experimental parameters including droplet size, water content, and imparted charge and generally cannot explore the reaction's reversibility. Here, an esterification reaction between a dicarboxylic acid and low volatility alcohol (that in bulk synthesis requires reflux at 160^{o}C for ~15 hours in non-aqueous solvent) is investigated in aqueous aerosol droplets spanning picolitre to sub-femtolitre volumes. Individual picolitre droplets generated without applied external voltage were confined within an Aerosol Optical Tweezers instrument and Raman spectroscopy used to resolve chemical change in the droplets. Flow tube experiments on sub-femtolitre aerosol droplets were conducted using both online aerosol mass spectrometry and off-line NMR spectroscopy. Across both droplet volume scales, the esterification was facile (<400 s in picolitre droplets, <2 s in sub-femtolitre droplets) upon droplet dehydration at room temperature. We demonstrate that both the forward and reverse reaction are vastly accelerated in aerosol compared to macroscopic solution. The unique aspects of this study include rigorous control over a water activity range spanning dilute to solvent-free conditions, investigation across a broad droplet volume range, application of multiple analytical techniques to confirm independently accelerated reactivity, and exploration of the reaction's reversibility. Combined, this study demonstrates how aerosols can drive chemistry in accordance with Le Chatelier's Principle on both the micro- and nano-scales.

10AC.4

Critical Assessment of Spontaneous Oxidation Chemistry in the Presence of Aqueous Aerosol. RYAN DAVIS, Paul Tumminello, David Schafer, Laura McCaslin, Christopher Kliewer, Leonid Sheps, *Sandia National Laboratories*

Aqueous, aerosolized microdroplet particles have unique properties that enable chemical processes not typically observed in a bulk solution. For example, microdroplets have been shown to accelerate many chemical reactions. Many of these unique droplet-based properties are generally well understood; Accelerated chemical reactions generally are thought to arise from a combination of factors, including reactant enrichment through water evaporation, droplet charging (either through applied voltage or contact electrification), interfacial enrichment of reactants, and partial solvation of reactants at the gas-droplet interface.

Microdroplets have also been reported to enable chemical reactions that otherwise do not occur in bulk solution without a catalyst or strong oxidant. For example, the oxidation of volatile hydrocarbon gas has been observed in the presence of water microdroplets. Unlike accelerated microdroplet chemistry, these so-called "spontaneous" microdroplet oxidation processes are less understood. Although speculative, these processes may arise from a combination of contact electrification and strong interfacial electric fields. Due in part to the uncertainty in mechanism, it remains unclear whether these processes occur in uncharged aerosol under equilibrium conditions, e.g., atmospheric aerosol.

Here, we report on efforts to uncouple the factors influencing droplet-catalyzed oxidation chemistry. Focusing on the oxidation of volatile organic carbons species, we perform experiments with aerosolized droplets in charged and neutral states, and under conditions where reactions can take place during non-equilibrium (i.e., during droplet generation and evaporation) and equilibrium conditions. We observe low-levels of oxidation even under neutral, equilibrium conditions. At present, however, we cannot rule out contributions from aerosol-surface interactions. We will discuss remaining uncertainties and potential sources of oxidation that must be addressed to move this field forward.

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10AC.5

How Surface Partitioning Regulates the Bulk Chemistry of Charged Microdroplets. MICHAEL JACOBS, Rebika Tamang, William Dean, Firoz Ahmed, Viola Fielgein, Jacob Twichell, Christian Haich, *Texas State University*

The chemical composition and acidity of the air-water interface are fundamental drivers of chemistry in microdroplets. Due to their large, exposed surface areas, a significant fraction of molecules in microdroplets reside at the air-water interface, where the chemical properties can be distinct from bulk solution. A primary point of contention is surface acidity. Historically, to assess surface acidity, a 'surface pKa' has been defined for molecules that can be shifted by several units relative to their bulk pKa values. However, it is debated if 'surface pKa' values reflect fundamental changes in surface chemistry or differences in partitioning between the protonated and deprotonated species. Furthermore, the influence of large net charges (often necessary to accelerate microdroplet reactions) on these surface properties is not well understood. Thus, the molecular origins of shifted surface pKa values of molecules and their relevancy in charged microdroplets remain unclear.

We use single droplet levitation experiments to study how the unique physicochemical properties of the surfaces of microdroplets and aerosol particles influence their bulk properties. Using model chemical systems, we measure the pH and surface tensions of levitated, charged microdroplets to gain insight into the chemistry of charged microdroplets. Here, we present recent experimental results from our laboratory aimed at understanding how the net charges on levitated microdroplets can alter the surface partitioning of molecules and bulk droplet acidity. Our results demonstrate that typically measured shifts in the 'surface pKa' values of alkyl acids can largely be explained by a simple partitioning model. However, in microdroplets, we find this value is further complicated by bulk-depletion effects. By measuring the surface tensions and pH of alkyl acid-laden microdroplets, we use our partitioning model to show that that the 'true' surface pKa of alkyl acids differs from its bulk value and that it can alter the bulk properties of microdroplets. Finally, we present preliminary data showing that large net charges on microdroplets can alter the partitioning of charged molecules to the air-water interface and discuss implications for changing microdroplet pH. Ultimately, these results contribute to a fundamental understanding of how the unique chemical properties of the air-water interface can alter the chemical composition of microdroplets to promote a wide array of chemical reactions.

10AC.6

Quantifying Gas-Particle Partitioning Through Single-Droplet Thermodynamics and Bulk-Phase Vapour Accretion. AJAY POTAVADOO, Jonathan P. Reid, *University of Bristol*

Accurate modelling of gas-particle partitioning and pure component vapour pressures remains critical for understanding atmospheric aerosol lifetimes and improving vapour detection. However, predictive group-contribution models frequently deviate from experimental data as chemical complexity increases. This study addressed these fundamental knowledge gaps through high-precision measurements of droplet evaporation dynamics of semi-volatile and low-volatility organic compounds.

To establish a reliable pure component vapour pressure library, we employed an electrodynamic balance (EDB) to track single-droplet evaporation rates under highly controlled conditions. Applying a Maxwellian flux framework and the radius-squared law allowed us to precisely derive vapour pressures for complex, multi-functional compounds. Initial results validated the EDB as a robust analytical technique and provided new estimates for a variety of organic compounds.

Building upon these thermodynamic fundamentals, we investigated the opportunity provided by ambient particles to accrete low-volatility analytes of interest for solid-phase detection using a tandem permeation oven and Scanning Mobility Particle Sizer (SMPS). We report studies that investigate the plausibility of using ambient aerosols to act as condensation surfaces and transport vectors for detecting and quantifying vapours. In particular, we quantify how ambient particles can facilitate vapour transport for detection by gas-chromatography mass spectrometry accompanied by measurements of evolving particle size distribution.

Ultimately, this dual-method approach bridged the gap between single-particle thermodynamics and ensemble aerosol dynamics. The experimental data provided the necessary parameters to be integrated into advanced dispersion frameworks. This significantly improved modelling sensitivity, establishing enhanced capabilities to predict vapour pressures.

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10AD.1 – INVITED

Martian Dust as an Aerosolized Health Hazard During Long-Duration Human Space Exploration. JUSTIN WANG, Jeremy Rosenbaum, Ajay Prasad, Robert Raad, Esther Putman, Andrea Harrington, Michael Raad, Haig Aintablian, Brian Hynek, *Keck School of Medicine, University of Southern California*

Future crewed missions to Mars will involve prolonged exposure to fine particulate dust with physicochemical properties capable of producing significant respiratory and systemic health effects. Unlike the brief lunar surface exposures experienced during Apollo missions, martian exploration architectures include extended habitat occupancy, repeated extravehicular activity, and chronic environmental contamination by airborne regolith. The small particle size, electrostatic behavior, and chemically reactive composition of martian dust raise substantial concerns regarding inhalation toxicity, pulmonary deposition, and cumulative long-term exposure.

Mineralogic and chemical data derived from rover-based analyses, orbital spectroscopy, and martian meteorites demonstrate that martian dust contains respirable silicates, iron oxides, perchlorates, gypsum, and trace heavy metals including chromium, cadmium, arsenic, and beryllium. Many of these compounds are associated with pulmonary inflammation, oxidative stress, thyroid dysfunction, neurotoxicity, and fibrotic lung disease in terrestrial occupational and environmental exposure settings. The predominance of respirable particles in the low micrometer range may facilitate deep alveolar deposition and prolonged pulmonary retention.

Electrostatic adhesion of dust to suits, equipment, and habitat surfaces may further complicate contamination control and increase cumulative exposure risk during long-duration missions. Recurrent dust intrusion into enclosed habitats represents a persistent operational and medical challenge in environments with constrained medical resources and delayed evacuation capability.

Current countermeasure strategies include advanced particulate filtration systems, dust-resistant materials and suit technologies, environmental monitoring systems, and targeted medical interventions aimed at limiting exposure-associated injury. Characterization of martian dust aerosol behavior and toxicologic potential remains critical for astronaut health risk assessment, operational planning, and the development of safe long-duration human exploration missions to Mars.

10AD.2

One Small Breath, One Giant Risk: Lunar Dust and Vascular Health. MARK OLFERT, Travis Goldsmith, Anand Ranpara, Evan DeVallance, *West Virginia University School of Medicine*

NASA's current permissive exposure limit (PEL) for humans to celestial dust is based on inhalation toxicity studies of lunar regolith that assumes episodic and limited exposure for up to 8-hours, with the expectation that habitat environmental control systems can mitigate airborne particles. While the existing PEL and no-observed-adverse-effect-limit (NOAEL) adopted by NASA may be suitable for lung health based on episodic/short-term exposures, it does not account for potential long-term exposures that might occur in upcoming ARTEMIS missions (involving habitation on the lunar surface for up to 6-months). Concern and susceptibility toward cardiovascular risk increase significantly with long-term (even at 'low' level) dust exposure. The cardiovascular system, and more specifically blood vessels and endothelial cells, are of great concern – given ample evidence that inhaled particulate matter adversely affects endothelial cells, arteriolar reactivity, and microvascular bed function. Notably, changes in blood vessel function often occur long before overt cardiovascular disease manifests. Using an in vitro cell model, and in vivo rat experiments, we tested the hypothesis lunar regolith exposure (at the existing PEL allowed by NASA) would be insufficient to protect against cellular and systemic vascular dysfunction. Our experiments revealed, 1) endothelial cells in culture exposed to just 50 ng of Lunar Highland Regolith (LHS-1D, Space Resources Technology Inc.) have reduced cell proliferation response to scratch assay ($p<0.05$), and 2) rats exposed 0.3 mg/m3 of LHS-1D for 4 days exposure (6 hr/day) exhibit impaired arteriole reactivity assessed by ex vivo myography. Rodents provide high-fidelity (patho)physiological outcomes for human responses to cardiovascular, sensory-motor and musculoskeletal health. Our data indicate that inhalation exposure to lunar regolith at levels currently accepted by NASA for human exposure may not be sufficient to protect astronauts from developing cardiovascular dysfunction and/or disease after living on the moon.

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10AD.3

Mars-Warming Effects of Natural and Engineered Aerosols, Past and Future. EDWIN KITE, Ashwin Braude, Adam Boies, *University of Chicago*

Although Mars is a cold, dry planet today, Mars was once warm enough for rivers and lakes. Mars could potentially be warmed in future through artificial warming ('terraforming'). Today, Mars' climate today includes regolith particles ('dust'), with dust storms contributing to important seasonal and interannual changes in surface temperature (Streeter et al. GRL 2019). Water ice cloud feedbacks on climate are relatively unimportant for Mars' modern climate, but simulations suggest that the greenhouse effect of water ice clouds could have been contributed to warming climates in the past (e.g. Madeleine et al. GRL 2014, Kite et al. PNAS 2021). In addition, recent research (Ansari et al. Science Advances 2024, Richardson et al. GRL 2026) suggests that artificial 'engineered' aerosols could enhance Mars' natural greenhouse effect as a first step to restoring surface habitability. However, any such effort would face great challenges in in-situ production of solid aerosol, size-sorting, engineering for radiative effectiveness, management of interaction between engineered and natural aerosol, and safe disposal/degradation of particles. This presentation will first review the role of aerosols on the present-day climate of Mars, and then assess the role they would have played in maintaining Mars' warm and wet climate in the light of geologic evidence from the Curiosity and Perseverance rovers. Next, we will discuss the motivation and current status for Mars-warming research, the feasibility and engineering challenges of using greenhouse-warming artificial nanoparticles (including 1-D and 3-D climate modeling results, radiative-dynamical feedbacks, and batch-production results), and open questions in this new area for aerosol research.

10AD.4

Physical and Chemical Characterization of Lunar Regolith Simulants: From Aerosols to Coarse Fraction. KRISTIN BUNKER, Marit Meyer, Traci Lersch, *RJ Lee Group, Inc.*

As NASA's Artemis program prepares for sustained human presence on the Moon, understanding the physical and chemical variability of lunar regolith is critical for dust mitigation and hardware longevity. This study characterizes a diverse suite of lunar simulants, including NU-LHT-2M, NU-LHT-4M, OB-1A, OPRH3N, CSM-LHT-1, JSC-1A, LHS-1D, and the Lunor and MXL prototypes. These materials represent both lunar highlands and low-titanium mare regions. Standardized sample preparation and advanced microscopy techniques were used to characterize the fine dust (<20 μm) and the coarse fraction (20–75 μm).

Automated computer-controlled scanning electron microscopy (CCSEM) integrated with energy dispersive X-ray spectroscopy (EDS) was used to analyze thousands of individual particles for size, shape, and elemental composition. High-resolution field emission scanning electron microscopy (FE-SEM) utilized secondary electron and backscattered electron imaging to evaluate topographic surface detail and atomic number contrast. Optical-SEM relocation was performed to correlate physical particle color with chemical composition. Furthermore, simulant particle size distributions and morphologies of the <20 μm fraction were compared to published Apollo lunar dust data. While elemental compositions obtained from CCSEM particle data showed good agreement with Apollo bulk X-ray fluorescence (XRF) results, differences were observed in modal particle diameters and the relative abundance of vesicular and molten forms.

Finally, we introduce Particle AI, a modular, Human-in-the-Loop (HITL) framework using ResNet-50 architecture to automate morphological characterization. This system integrates deep learning with classical statistical descriptors to identify morphological features, such as vesicular structures, angular shards, and blocky fragments. This study provides characterization across multiple size fractions that can assist engineers in selecting simulants with the specific properties required to support mission-critical hardware testing and the development of dust mitigation strategies.

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10AD.5

Opera Sensor Characterization of Aerosolized Lunar Dust Simulants. Sreekesh Kookkal, Marit Meyer, SURESH DHANIYALA, *Clarkson University*

Dust in extraterrestrial environments has an unknown impact on human health and surface operations. From past experience, it is well understood that Lunar and Martian lander systems result in the generation and resuspension of a large concentration of dust in their immediate vicinity. With human ingress and egress through the lander systems, the dust can penetrate into the vehicles. The detection of dust in the habitable spaces is critical for initiation of mitigation efforts, determining their effectiveness, and alerting the crew of unsafe conditions. For this, there is a need to identify sensors that can accurately detect and measure concentrations of dust while operating at low pressures. In this study, we use 3 different lunar dust simulants to evaluate the OPto-Electrical Real-time Aerosol (OPERA) sensor for its ability to selectively detect these simulants. The mass concentrations reported by OPERA were compared against research grade instruments (ELPI and APS). In this presentation, we will highlight the best practices for dust generation and testing and the performance of OPERA for dust classification and concentration measurements.

10AE.1

Dense Low-Cost Sensor Networks Improve Neighborhood-Scale AQI Representation. Kate DeMarsh, Peizhi Hao, Yaying Wang, Zeyi Moo, XUAN ZHANG, *University of California Merced*

Air quality information is commonly communicated through the Air Quality Index (AQI), which residents often interpret using the nearest available monitor. Motivated by this real-world use pattern, we evaluated how well different monitoring networks represent local AQI across California's San Joaquin Valley, one of the most persistently polluted regions in the United States. We used the Global Historical Air Pollution (GHAP) $PM_{2.5}$ dataset as a spatially continuous reference surface to distinguish point-level agreement from neighborhood-scale representativeness. We found that although regulatory monitors showed the closest overall agreement with GHAP in absolute $PM_{2.5}$ concentration, their sparse distribution limited their ability to capture neighborhood-scale AQI. In contrast, when AQI was assigned from the nearest available site, the denser low-cost sensor network produced a higher proportion of locations with the same AQI category as GHAP. This contrast was most evident under polluted conditions, when stronger spatial heterogeneity increased the importance of nearby observations for resolving neighborhood-scale AQI. Under such conditions, even uncalibrated low-cost sensors outperformed regulatory monitors despite lower accuracy in absolute PM2.5 concentration. These findings suggest that dense low-cost sensor networks can improve the local representativeness of public-facing AQI information despite inherent measurement uncertainty.

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10AE.2

An Intercomparison of High-Resolution Models for Air Quality Environmental Justice Applications. JOHN ALLEN, Peter Adams, *Carnegie Mellon University*

Fine particulate matter exposure leads to around 100,000 premature mortalities each year in the United States, but exposure to fine particulate matter is not uniform across racial and ethnic groups (REGs). Reduced Complexity Models (RCMs) are air-quality models capable of predicting particulate matter concentration changes at higher resolutions than chemical transport models. This analysis compares the environmental justice outcomes of two RCMs, InMAP and REACH, with a third model, EASIUR, currently being analyzed. Using emissions from the National Emissions Inventory, concentrations of $PM_{2.5}$ were predicted across the contiguous United States. The emissions were separated into 12 different source sectors. Population-weighted exposures were calculated for each of the 12 source sectors for five different REGs. Percent disparities were calculated in the same form, relative to the total population weighted exposures. Results with county resolution emissions show reasonable agreement between the two RCMs across REGs. Across all source sectors combined, InMAP predicts more exposure to Black Americans, while REACH predicts more exposure to Asian Americans. White, Hispanic, and persons of color have similar predicted exposure across models. Emissions from the industrial and coal-fired electricity generation source sectors cause the most total exposure. Residential gas combustion and commercial cooking show the largest percent disparities in the Asian population at 88% and 82% for REACH, and 76% and 91% for InMAP, respectively. Black Americans are exposed more than Americans on average across 11 source sectors for REACH, and all 12 for InMAP. REACH predicts approximately twice the percent total exposure from coal-fired electricity generation as compared to InMAP. InMAP predicts higher percent total exposure from onroad vehicles and agriculture, though the difference between models is within a factor of two. Additional results from census tract resolution emissions for REACH and 1 km resolution emissions for InMAP and EASIUR are anticipated in the coming months.

10AE.3

Analyzing Drivers and Scales of Air Pollution in California's Overburdened Communities. LUCAS ROJAS-MENDOZA, Libby H. Koolik, Yuzhou Wang, Cassidy Barrientos, Alper Unal, Julian Marshall, Joshua S. Apte, *University of California Berkeley*

Residents of California's Community Air Protection Program (AB 617) communities experience on average higher fine particulate matter ($PM_{2.5}$) exposure than the statewide population. The spatial origins and sectoral drivers of this exposure at the community level remain poorly characterized. We use the InMAP Source-Receptor Matrix and the 2017 National Emissions Inventory to model $PM_{2.5}$ exposure for three spatial arrangements (all of California; all 19 AB 617 communities combined; each AB 617 community individually), disaggregated by spatial origin and nine economic sectors. Statewide modeled population-weighted $PM_{2.5}$ exposure is 7.7 $\mu g\ m^{-3}$, compared to 10.7 $\mu g\ m^{-3}$ for the aggregate of all AB 617 communities. Approximately 56% of $PM_{2.5}$ exposure for all AB 617 residents originates from emissions outside the community boundaries. For AB 617 residents overall, industrial emissions are the largest contributor both within and outside community boundaries; the second-largest driver differs by emissions origin. Sectoral drivers vary across individual communities, with agriculture, industrial, transportation, and residential sources consistently emerging as dominant contributors. Our findings suggest that within-boundary emissions controls alone may be insufficient to achieve equitable exposures for AB 617 communities.

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10AE.4

Spatial Variability of Oxidative Potential and Chemical Composition of PM2.5 from Transportation Sources in Los Angeles. ZHUOYING LIN, Yuan Yao, Caleb Kwon, Alex Chang, Kyle Caulson, Yifang Zhu, Suzanne E. Paulson, *University of California, Los Angeles*

Non-tailpipe emissions represent a persistent and growing source of air pollution. In this study, we conducted a stationary sampling campaign at 68 locations across Los Angeles to characterize spatial variability in PM2.5 composition and oxidative potential (OP) near non-tailpipe transportation-related environments, including brake and tire wear, heavy rail, direct current fast charging (DCFC) stations and paired gas stations, and Los Angeles International airport (LAX). At each site, two-week PM2.5 samples were collected on Teflon filters and analyzed for chemical composition, including black carbon (BC), elements and OP using the OH radical (OP^{OH}) and dithiothreitol (OP^{DTT}) assays. Results indicate sites near LAX and rail have elevated volume-normalized OP_v across the campaign, while OP levels at DCFC stations were not statistically different from their paired gas stations. Further, we will discuss the relationship between OP and community-level socioeconomic vulnerability using CalEnviroScreen, and its relationship with the elemental content of particles.

10AE.5

Using Machine Learning to Develop Improved Exposure Models of Ultrafine Particles near the Los Angeles International Airport. KYLE CAULSON, Steven Buschmann, Zhuoying Lin, Alex Chang, Michael Jerrett, Suzanne E. Paulson, *University of California, Los Angeles*

Ultrafine particles (UFP; particles smaller than 0.1 µm in diameter), which are largely generated through combustion, can pass through cell membranes and affect organs beyond the lungs. Their impacts on human health are an area of growing concern, highlighting the need for improved exposure estimates. While modern regulations have reduced ambient UFP levels in urban areas, aviation emissions remain as a major source.

The Los Angeles International Airport (LAX) is among the world's busiest airports in both passengers and cargo. Standard operations take arrivals over central and western Los Angeles. In addition, onshore winds predominate during the day, driving pollution generated by aircraft and airport activity over nearby communities.

Previous exposure estimates around LAX are based mostly on physical dispersion models. While these models capture the broader scale and structure of the pollution plume, they struggle to fully resolve fine scale spatial variability in complex environments, and have to make assumptions about the atmospheric dynamics, geography, and emission rates. In contrast, machine learning approaches can leverage large observational datasets and heterogeneous predictor variables to learn nonlinear relationships and localized patterns in pollutant concentrations. Developing these models can improve the spatial and temporal resolution of UFP exposure estimates.

From December 2024 - present, we conducted a mobile measurement campaign around LAX measuring UFPs and black carbon. Results show a clear UFP plume extending more than 15 km downwind of the airport. We combine our measurements with meteorological, land use, traffic, and aircraft activity data to develop high resolution exposure models using random forest regression, regression kriging, and other machine learning techniques. Results identify dominant drivers of exposure and improve estimates of population level impacts near the airport.

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10AE.6

Size and Composition Distribution of Particles Emitted from Tungsten Inert Gas (TIG) Welding. MICHAEL KLEEMAN, Peter Green, Yuejun Zhou, *University of California, Davis*

Tungsten Inert Gas (TIG) welding has relatively low total fume emission rates but TIG welding of metals that contain significant amounts of metals such as chromium (Cr) may emit toxic ultrafine particles (Dp < 100 nm). Here we measured emissions of metals from TIG welding of stainless steel as a function of particle size using cascade impactors and filter-based samplers. More than 30 controlled laboratory tests and 20 field tests were conducted on a range of base materials, filler materials, and shield gases. Particles emitted from stainless steel TIG welding had a log-normal size distribution with a geometric mean diameter of 100 nm. All measured components, including hexavalent chromium (Cr(VI)), had similar size distributions. The median fraction of Cr converted to Cr(VI) was 30.5% in laboratory chamber studies and 11.1% - 20.6% in open shop welding tests. Cr(VI) conversion fractions were notably higher when chlorine associated with manufacturing oils was present in the welding fumes. Changes in stainless steel type and base material thickness did not strongly affect the Cr(VI) conversion fraction. Despite higher-than-expected formation efficiency, Cr(VI) emission rates measured from TIG welding were 100x to 500x lower than rates estimated in standard emissions inventory calculations because the fume generation rate, fraction of metals in fumes, and Cr fraction of metals were all over-estimated by an order of magnitude. These findings have implications for communities surrounding industrial locations that perform TIG welding.

10CM.1

Evaluating Real-World Performance of HVAC Filtration and Air Cleaning Interventions in Commercial and Institutional Buildings. Rafsan Nahian, Michelle Wu, David Kormos, JEFFREY SIEGEL, *University of Toronto*

Air filtration is a widely implemented intervention to reduce indoor particulate matter; however, its real-world performance remains poorly characterized. Standardized testing methods, like ASHRAE Standard 52.2, provide consistent performance metrics but do not capture dynamic factors including HVAC operation, building characteristics, and temporal variability in particle sources. This study evaluates the real-world effectiveness of filtration-based interventions across nine commercial and institutional buildings by assessing four in-duct HVAC filter types (MERV 8, MERV 8 electret, MERV 13 electret, and active polarization) and a portable air cleaner, with each intervention deployed for one week per site. Concentration reduction was quantified as the change in indoor $PM_{2.5}$ relative to a low-efficiency screen baseline by using an analysis of covariance (ANCOVA) framework. Results demonstrate that the absolute $PM_{2.5}$ reductions ranged from 0.76 to 3.87 $\mu g/m^3$ for MERV 8 filters and from 1.72 to 9.99 $\mu g/m^3$ for MERV 13 electret filters, with greater benefits observed in environments with higher indoor or outdoor PM sources and where filtration dominated other loss mechanisms. The magnitude of PM removal was dependent on occupancy, space volume, and fan runtime, reflecting differences in particle generation, dilution, and the duration of active filtration. These findings highlight the importance of evaluating exposure-reducing interventions under real-world conditions. By integrating field measurements with statistical adjustment for environmental variability, this work supports more realistic and actionable assessments of air cleaning strategies.

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10CM.2

Impacts of Real-World Differences on the Performance of Do-It-Yourself Air Purifiers. PRADEEP KUMAR, Misti Zamora, Hannah Cooke, Marina Creed, Jessica Hollenbach, Alexis West, Tia Nakhoul, Kristina Wagstrom, *University of Connecticut*

Poor classroom ventilation creates an environment where particles can accumulate, leading to reduced indoor air quality, heightened risks of infectious disease transmission, and exacerbating asthma symptoms. Low-cost DIY air purifiers, such as the Corsi-Rosenthal box (CR box) offer a practical and accessible intervention. We conducted a comprehensive assessment of DIY configurations (20” fan with 1 and 4 filters, and 12” fan with 5 filters) operating within a controlled laboratory, occupied residential setting, or educational spaces. We also evaluated performance across different fans and filter brands. Furthermore, we intentionally introduced common construction errors to simulate real-world deployments, including reversed filters, poorly sealed tape gaps, lightly blocking sides of the purifier to simulate placement against walls and furniture, creating the wrong shroud size, and using dirty or damaged filters. While the standard 20-inch four filter cube model provided the highest clean air delivery rates (CADR; 301 – 475 cfm), the most notable finding was the robust performance of the smaller models. While the CADRs produced by the single 2-inch filter on a 20-inch box fan (74-184 cfm) and compact 12-inch cube models (63-140 cfm) were about a third of the full cube, they achieved comparable CADRs to many commercial units. Increasing the fan speed or using a dirty filter had little impact on the CADR. Overall, variations in brands, construction errors, and minor physical filter damage did not meaningfully decrease the purifiers’ performance in any of the settings. Altogether, our results increase confidence in the effectiveness of DIY air purifiers built by those without extensive training and when exposed to real-world occupied spaces.

10CM.3

Filtration Efficiency of MERV 13 Filters Before/After Continuous Use in an Extremely Polluted Environment > 500 mcg/m3. DEVABHAKTUNI SRIKRISHNA, Esther Jung, Carla Ribeiro, Lara Pereira, Paulo Dos Santos, Roberto Oliveira, Julio Croda, Jason Andrews, *PatientKnowhow.com*

Prior studies at AAAR demonstrated retention of filtration efficiency of MERV 16 filters with daily use during school hours over a year or more in schools in San Francisco, whereas longevity of MERV 13 filters when used continuously in DIY air purifiers under extremely high particle concentrations such as those during wildfire smoke events around the world or during in winter in New Delhi, India remains an open question. This specific study was performed in one medium-security prison in Campo Grande, the capital of the Mato Grosso do Sul state in Central Western Brazil, where DIY air purifiers based on a single box fan and MERV 13 filter were trialed for air cleaning. PM 2.5 concentrations were recorded in the "worst polluted cell" reaching as high as 500 to 1000 mcg/m3 using an Atmo Pro 1 portable air quality monitor to allow 24 hour measurements, comparable to those observed during the winter in New Delhi, India. For filtration efficiency, the procedure uses a Temtop PMD 331 (2.5um bin) based on the procedure in Srikrishna, Science of The Total Environment Volume 838, Part 1, 10 September 2022, 155884 (https://doi.org/10.1016/j.scitotenv.2022.155884). We have done this with one device each in two cells since February 11, 2026. For the first set of filters, we observed device #1 start at 81% efficiency, device #2 start at 77% efficiency on February 11. On March 18, #1 was at 29% efficiency and #2 was at 32% efficiency. We then replaced the filters in both devices on March 18. Device #1 started at 80% efficiency and device #2 started at 65% that day. On April 1st, #1 was at 29% efficiency and #2 was at 32%. In conclusion, the filter efficiencies dropped significant over the course of 2-3 weeks. For both wildfire smoke preparedness globally and prolonged, extreme pollution such as in New Delhi three strategies maybe used to mitigate the observed rapid deterioration based on longevity and operational convenience, and future work can identify the associated tradeoffs by working out the impact on filter replacement time intervals (1) Frequent MERV 13 replacement typically done during wildfire smoke events (2) multiple DIY air cleaners to distribute the particle loading and extend life of each filter versus just one (3) addition or MERV 5 lint fllter to prefilter as many particles as possible and replace MERV 5 more frequently as it loads up to preserve MERV 13 longevity (4) combinations of the above.

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10CM.4

Wildfire Smoke Particle Removal Efficiency of a Window AC Unit and Portable AC Unit Using Six Different Filter Medias.
RILEIGH ROBERTSON, Henrik Helmig, Marina Vance, *University of Colorado Boulder*

Wildfires generate large amounts of particulate matter (PM), which pose significant health risks when inhaled. Indoor air filtration plays a critical role in reducing exposure but can be expensive. There is currently limited research investigating the performance of low-cost solutions that also address thermal comfort. In this study, we developed and evaluated the PM removal efficiency of 6 different materials inserted into window and portable air conditioning units during a simulated wildfire event. A cocktail smoker with Ponderosa Pine chips was used to inject the PM into a 38 m3 chamber and left to decay with the AC units running. Particle sizers were used to measure the PM concentrations ranging from 10 nm to 10 µm. Clean air delivery rates were calculated for each of the filters, and the pressure drop was measured. All tested filters outperformed the control, confirming that the filter materials car reduce occupant exposure to wildfire smoke. CADRs ranged from 14 to 36 cfm, which would be sufficient for a small room. These solutions are low cost and use a device that the home may already have with the added benefit of cooling to maximize comfort, effectiveness, and cost.

10CM.5

The Effect of Filter Media Thickness on the Performance of Pleated Filters.
PEI-HUA WU, Sheng-Hsiu Huang, Chih-Wei Lin, Yu-Mei Kuo, Chih-Chieh Chen, *National Taiwan University*

Due to space constraints, air purifiers equip pleated filter media to increase surface area. Our previous studies identified an optimal flat-filter thickness that maximizes CADR under fixed blower and filter surface area. This study aims to explore how filter media thickness influences the optimal pleat geometry for achieving high filtration efficiency and low pressure drop.

The study combined numerical simulations with controlled experiments. The numerical simulations applied single-fiber theory to predict the pressure drop and filtration efficiency of flat media. Filter materials were folded into the desired pleat height (P_H, cm) and pleat count (P_c, pleat/cm). Total filtration efficiency was measured using a condensation particle counter (CPC), while particle-size–resolved filtration efficiency was determined by a scanning mobility particle sizer (SMPS). A pressure transducer measured the pressure drop.

The experimental results showed that increasing P_c increased the effective filtration area (EFA). The shrinking channel spacing between pleats from excessive P_c led to a higher frictional drag, while the increased dead zone reduced the EFA. Under the same P_c and P_H, thicker filters achieved high filtration efficiency but exhibited significantly higher resistance due to filter-media resistance and friction losses. Several one-layer pleated filters with short P_H were arranged vertically to replace the thick pleated filter. This design allowed high filtration efficiency and low pressure drop, indicating that a high percentage of EFA was preserved. For example, when P_c=1, the new design allowed a 30% decrease in pressure drop while maintaining the same filtration efficiency.

The series short PH design is superior to the traditional design for its high filtration efficiency and low pressure drop. The manufacturing process of pleated filter assemblies is crucial for maintaining precise channel spacing. Further research may focus on optimizing the spacing between the short pleats to improve filtration performance.

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10CM.6

Evaluation of Portable Air Purifiers, Cabin Filters, and Test Methods for Vehicle Cabin Air Quality. EVAN RENCK, Heejung Jung, *University of California, Riverside*

The study consists of three parts.

Part 1: We tested portable air purifiers ranging in size from small desktop units to large plug-in filters with large flow rates to evaluate their performance in reducing PM and NOx concentrations inside vehicle cabins. The goal was to determine the minimum size (in terms of flow rates) for a supplemental portable air purifier to aid the existing cabin air filter.

Part 2: We tested aftermarket cabin air filters with various types of carbon trap features to evaluate their performance in reducing NOx concentrations inside vehicle cabins. The goal was to determine the effectiveness of the carbon trap elements.

Part 3: The standard test protocol uses a couple of target gases such as NO2 and benzene to represent diluted vehicle exhaust gases on the road. We think the target gases are unrealistic compared to the air on the road. We will present a new test protocol and method to evaluate adsorption type cabin filters using diluted diesel exhaust. We tested premium adsorption cabin filters available from OEMs for this study.

10HR.1

Quantifying the Synergistic and Antagonistic Effects of Metal–Organic Complexation on Aerosol Oxidative Potential via Redox Kinetics. SATOKO KAYABA, Yuji Fujitani, *National Institute for Environmental Studies*

Oxidative potential (OP) is an indicator of the ability of redox-active species (e.g., transition metals) in aerosols to generate reactive oxygen species (ROS) and induce oxidative stress. Previous studies have reported non-additive (synergistic or antagonistic) OP effects in mixtures of metals and non-redox-active organics. These effects have been attributed to changes in redox potential and kinetics associated with complexation; however, the quantitative validity of this hypothesis remains unclear. In this study, we evaluated this hypothesis using a new chemical equilibrium–kinetic model of DTT assay (CEK-DTT model) for Fe–oxalate systems. The model reproduced the observed non-additive interactions, indicating that the proposed redox-potential-driven kinetic mechanism can quantitatively explain these effects under the examined conditions. At atmospherically relevant oxalate-to-Fe ratios, Fe–oxalate complexation enhanced Fe(II)-driven oxidant reduction kinetics but did not produce strong synergy. Accelerated Fe(II) oxidation shifted the Fe redox balance toward Fe(III), decreasing Fe(II) concentrations and offsetting much of the kinetic enhancement. At higher oxalate-to-Fe ratios, strong antagonism arose from suppression of Fe(III)-driven DTT oxidation by weakly reactive Fe(III)–oxalate species. These results revealed that non-additive OP effects cannot be inferred from complexation-induced changes in rate constants alone, but are determined by the combined effects of reaction kinetics, chemical speciation, and metal redox balance.

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10HR.2

Crowdsourcing a National Monitoring Network for PM2.5 Mass, Metals, and Oxidative Potential. JULIAN PROBSDORFER, Emilio Molina Rueda, Christian L'Orange, Xiaoying Li, Bonnie Young, Abby Evans, Tessa Jorgensen, Michelle Bell, Scott Weichenthal, Xiao Wu, Krystal Godri Pollitt, Francesca Dominici, John Volckens, *Colorado State University*

Monitoring networks that speciate ambient PM2.5 (e.g., to determine concentrations of metals, black carbon, or oxidative potential) tend to be expensive, labor-intensive, and geographically sparse. PM-OPERA (Particulate Matter Oxidative Potential Exposure and Risk Assessment) is a national, crowdsourced network that seeks to reduce the cost and complexity of PM2.5 speciation sampling, leveraging low-cost technology and community-based participatory research. Launched in 2026, PM-OPERA aims to characterize PM2.5 mass, metals, and oxidative potential across 60 US cities using 117 samplers over a 24-month period. This work describes the development and characterization of "CAM", the Community Air Monitor designed to enable PM2.5 speciation sampling by non-scientists for <$1000 a unit. CAM combines an ultrasonic personal air sampler (UPAS) and a low-cost aerosol sensor (PMS5003) with a solar panel, a high-capacity battery, and a cellular modem to enable continuous, remote operation. Weighing ~11 kg and with a footprint of 0.51 m x 0.35 m x 0.31 m (~9 kg and 0.25 m x 0.14 m x 0.31 m without the solar panel), CAM utilizes a simple slide-and-lock mounting system to simplify backyard installation. CAM sends and receives cellular data at 5-minute intervals to a free, web-based dashboard where users (and administrators) can visualize system diagnostics and real-time PM2.5 data. Under this operating model, CAM is set up and maintained by volunteers but operationally controlled and monitored by researchers; this arrangement reduces participant burden, improves quality control, and streamlines network efficiency. Using smartphones and sample-specific QR-codes, users can log into their instrument dashboard, load new samples, and visualize their real-time data. Sequential, two-week integrated filter samples are refrigerated and returned using pre-paid shipping containers for subsequent analysis via gravimetry (mass), optical attenuation (black carbon and oxidative potential), and X-ray fluorescence (metals). Co-located CAM units collecting integrated PM2.5 samples at a flow rate of 1 L·min-1 show a coefficient of variation of 15% for a two-week sample at low concentrations (3.6 µg·m-3) and 3% for an 8-hour sample at high concentrations (641 µg·m-3). Co-located OP^{AA} measurements show coefficients of variation below 26% between 0.05 and 0.42 % depletion µg-1. Solar power simulations of the continental US demonstrated an 86% success rate for integrated 2-week filter samples.

10HR.3

Relationship Between Aerosol Light Absorption and Oxidative Potential During Photochemical Aging in an Urban Environment. LI-TI CHOU, Jian-Xian Wu, Chia-Hsin Lin, Shu-Wen You, Rajan K. Chakrabarty, Ta-Chih Hsiao, *National Taiwan University, Taiwan*

Light absorption and oxidative potential (OP) of atmospheric particulate matter (PM) share a common molecular structural basis, as conjugated π-electron systems simultaneously support visible-light absorption and the electron-transfer reactivity that underlies redox cycling. This structural commonality provides a theoretical expectation for co-variation between these two properties. Atmospheric aging, however, transforms chromophoric and redox-active functionalities asymmetrically; oxidative fragmentation and photobleaching degrade primary light-absorbing structures, while concurrent oxidative processing generates new redox-active species that enhance OP. Laboratory and field evidence confirm that this asymmetric response is highly pathway-dependent, yet the conditions under which aerosol light absorption and OP remain coupled or diverge during aging remain poorly constrained in complex urban environments. We conducted a one-week intensive field campaign at an urban roadside site in Taichung, Taiwan, specifically designed to track aerosol light absorption, atmospheric oxidation state, and oxidative potential simultaneously across diurnal cycles. Light absorption was characterized by the imaginary refractive index at 550 nm (k_{550}), and atmospheric oxidation state was represented by hydroxyl radical concentrations simulated with the AtChem2 box model driven by the Master Chemical Mechanism. OP was assessed through DTT assay at 3-hour resolution, yielding both volume-normalized OP_v and mass-normalized OP_m. Source-specific contributions to OP were further apportioned by combining positive matrix factorization with multivariate regression analysis. OP_v and OP_m exhibited inverse diurnal patterns. OP_v peaked during morning traffic rush hours tracking primary emissions, whereas OP_m reached its maximum at midday under intense photochemical activity, indicating that aged particles carry substantially higher intrinsic toxicity per unit mass. Both k_{550} and OP_m varied with atmospheric OH levels, but in contrasting ways. k_{550} increased during early-stage oxidation but declined at higher OH exposure, while OP_m rose steadily with increasing oxidation. Source apportionment further showed that aged traffic and industrial/combustion factors dominated intrinsic toxicity, whereas fresh traffic contributed minimally despite comparable mass.

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10HR.4

Linking Air Pollution Determinants to Health Outcomes via Oxidative Potential: The PolluRisk 2.0 Platform for Multi-Atmosphere in Vitro and in Vivo Exposure Studies. PATRICE COLL, Ambre Delater, Christina Vasilakopoulou, Aline Gratien, Lisa Guth, Christopher Ferland, Lucy Gerard, Mathieu Cazaunau, Edouard Pangui, Bénédicte Picquet-Varrault, Thomas Audoux, Laurent Alleman, Esperanza Perdrix, Davy Rousset, Albane Barbero, Anouk Marsal, Gaëlle Uzu, Audrey Der Vartanian, Clément Buissot, Benjamin Simonneau, Sophie Lanone, The PolluRisk Team, *Université Paris Cité and Univ Paris Est Creteil, CNRS, LISA*

Air pollution causes 6.67 million premature deaths annually, yet assessing the health impact of complex aerosol mixtures remains challenging. Current regulations based on PM mass concentration are limited to capture differential toxicity across particle sizes and chemical compositions. **Here, we evaluate the Oxidative Potential (OP) as a relevant metric to overcome this limitation by measuring the intrinsic capacity of an entire air mass to oxidize the lung environment, regardless of its specific chemical constituents.**

Scientific point: Using the PolluRisk platform, we demonstrate that OP can effectively link atmospheric determinants to actual health impacts. In proof-of-concept experiments, mice (both healthy and with pulmonary weaknesses) were exposed for 7 days to two realistic atmospheres: a moderately polluted city, and the same city with added biomass burning. We measured acellular OP (Ascorbic Acid and Dithiothreitol assays), while we assessed health effects via bronchoalveolar lavage cytometry. Our results show that OP variations correlate with biological responses, confirming that OP may integrate the toxic potential of various aerosol sources into a single health-relevant metric.

Technical point: After a decade of transdisciplinary experiments with the PolluRisk platform, we are presenting PolluRisk 2.0, a new-generation platform featuring an advanced exposure chamber that enable simultaneous in vitro and in vivo exposures coupled with offline/online OP monitoring. This upgrade allows the controlled generation of various individual atmospheres (urban/periurban pollution, with or without biomass burning, dust, pollen, metals…) and, critically, their realistic cocktail mixtures, overcoming the limitations of single-pollutant approaches. Thus, PolluRisk 2.0 provides a unique tool to unravel how combined exposures drive oxidative stress and morbidity.

10HR.5

Metal-Carbonaceous Aerosol Complex as a Driver of PM2.5 Toxicity in High-Rise Urban Buildings. AVNISH SHUKLA, Shreya Dubey, Vinayak Sahota, Harish C. Phuleria, *Indian Institute of Technology Bombay*

High-rise living offers cleaner air with elevation; this assumption remains weakly validated when considering aerosol composition and toxicity. While previous studies characterized $PM_{2.5}$ mass and elemental composition, the role of metal-carbonaceous complexation in driving toxicity remains unexplored. This study investigates the trace metals on carbonaceous fractions influencing oxidative potential (OP) at building heights in Mumbai, India. $PM_{2.5}$ gravimetry-based monitoring was conducted at four heights (20m, 50m, 80m, 110m) in a residential high-rise. Samples were analyzed for carbonaceous species (OC and EC) via IMPROVE-A protocol, trace metals (Fe, Cu, Zn, Cr, Ni, Mn, Pb, Al, V, Cd) via ICP-OES, light-absorbing properties (b_{abs} at 370nm and 880nm) via transmissometer, and OP via acellular assays (OP^{DTT} and OP^{AA}).

Results revealed that iron enrichment on black carbon, peaking at 50m (Fe/EC = 0.26), was strongly correlated with OP^{DTT} (r = +0.85), indicating Fenton-type electron transfer and contradicting the assumption that air quality improves with height. However, despite a lower concentration of $PM_{2.5}$ at 110m, Zn (0.13 $\mu g/m^3$) and secondary organic carbon (SOC) strongly correlated with OP^{AA} = 0.4 (r = +0.95 for Zn). $PM_{2.5}$ peaked at 50m (56 $\mu g/m^3$) yet shows negligible correlation with toxicity (r = -0.08), whereas metal ratios showed strong correlations, demonstrating that composition drives toxicity, not mass alone. Furthermore, the AAE range 0.9-1.3 indicates source-dependent metal uptake, fossil fuel BC domination at 50m, while aged secondary aerosols dominate at 110m. A distinct clean air zone emerged at 80m with the least $PM_{2.5}$ and both OP levels, but peaking at AAE (1.3), suggesting efficient vertical mixing and secondary processing at this height. These findings indicate that building recirculation results in metal-enriched emissions at 50m, and long-range transport delivers Zn-enriched aerosols to 110m. Metal-carbonaceous associations drive toxicity, necessitating metal-inclusive assessment and implications for building design and air quality standards.

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10HR.6

Size- and Time-Resolved Emission Rates of Particulate Matter Mass, Chemical Constituents, and Oxidative Potential from Indoor Sources. P. S. GANESH SUBRAMANIAN, Anson Regi, Saman Haratian, Mohammad Heidarinejad, Brent Stephens, Vishal Verma, *University of Illinois Urbana-Champaign*

Oxidative potential (OP) quantifies the ability of particulate matter (PM) to induce oxidative stress in humans and is used as a surrogate of PM toxicity. Although most of the human exposure to particulate matter (PM) typically occurs indoors, both the temporal and the size-resolved variations in the oxidative potential (OP) and chemical composition of PM from indoor emission sources are still unknown.

Here we quantify the time- and size-resolved emission rates of PM mass, its chemical constituents [metals and elemental/organic carbon, (EC/OC)], and OP (using the dithiothreitol assay) from six indoor emission sources [incense (patchouli), incense (frankincense), unscented candles in the presence of a wind-draft, cigarettes (environmental tobacco smoke), and toasters (maximum browning)] in a chamber. Both the mass-normalized OP (OP^m) and chemical composition did not vary much temporally, suggesting limited transformations of primary emissions occurring in the chamber. However, both the chemical composition and OP^m varied with particle size, with quasi-ultrafine particles (Q-UFPs < 0.25 µm) constituting 68 ± 20 % of the total emitted PM mass and having the highest OP^m and EC fractions across the six sources.

Respiratory-deposition modeling revealed that about 40 ± 4 % of the total respirable PM and OP is likely to deposit in the respiratory tract (RT), because of the Q-UFP's disproportionate contribution to both (81 ± 15% of RT-deposited and 87 ± 12% of alveolar-deposited) PM mass and OP. Preliminary exposure assessments suggest that the total dose of OP delivered to the most vulnerable regions (e.g., alveolar) of the RT is determined by not only the size-resolved particle emission rates and OP^m, but also the usage duration of each source. Collectively, these results emphasize the need to better quantify the size-resolved emission rates, and toxicological properties of PM from myriad emission sources to reliably estimate the resulting health risks.

10WF.1

Contamination of the Indoor Environment by WUI Fire Smoke. MICHAEL LINK, Nathan Lima, Aika Davis, Ryan Falkenstein-Smith, Thomas Cleary, Steven Emmerich, Dustin Poppendieck, *National Institute of Standards and Technology*

Fires occurring at the wildland-urban interface (WUI) can produce smoke, that contains unique chemicals from the combustion of urban structures, which can then contaminate nearby buildings and affect indoor air quality. Assessing property loss and possible occupant exposure to persistent contamination from WUI smoke is challenging, in part because of a lack of measurements detailing chemical contamination in real indoor environments before and after WUI events. In this presentation we highlight the research NIST is doing to quantify indoor contamination by simulated WUI fire smoke using their test house and fuel packages meant to generate smoke with the chemical composition representing combustion of a typical residential building. We will present on our findings demonstrating the development of non-methane organic gas emission sources indoors from WUI smoke contamination that affect indoor air quality for months after the contamination events. We will present preliminary results evaluating the effectiveness of commonly used air oxidation treatments (ozone and hydroxyl radical generators) as smoke remediation tools. Finally, we will present on current gaps in knowledge that WUI smoke researchers could investigate to help improve documentary standards and practices for indoor smoke contamination.

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10WF.2

Drywall as an Indoor Reservoir for Wildfire Smoke VOCs: Effects of Paint Layer and Porosity. RACHEL HURLEY, Anita Avery, Manjula Canagaratna, Mitchell Alton, Fatemeh Ghajari, Nima Rahbar, Albert Simeoni, Chenyang Bi, Shichao Liu, *Worcester Polytechnic Institute*

While wildfire smoke is a known health hazard, how indoor surfaces prolong volatile organic compound (VOC) exposure is often overlooked. Smoke-derived VOCs sorb into porous building materials and re-emit for weeks or months, even for the most volatile species. Understanding the emission dynamics, including the peak emission rate, which corresponds to peak exposure dose, and the emission timescale, which corresponds to exposure duration, can help with post-wildfire decision-making such as aiding smoke-impacted homeowners to determine when it is safe to return home.

In this study, peak emission rates and emission timescales of VOCs in smoke-exposed drywall are experimentally evaluated, with a focus on the roles of material porosity, the presence of a paint layer, and chemical vapor pressure. Using a rapid-emission chamber and a Vocus CI-ToF, emissions of 23 VOCs are measured from smoke-contaminated aluminum, drywall, and painted drywall samples, with porosity and layer thickness quantified by micro-computed tomography. Both painted and unpainted drywall exhibit a large capacity to sorb and re-emit wildfire smoke-derived VOCs, with peak concentrations up to two orders of magnitude higher than the impervious aluminum reference. Comparisons between intact and paint-peeled drywall show that paint acts as a selective barrier, trapping lower-volatility species at the surface while allowing more volatile compounds to diffuse into the gypsum core, with the extent of penetration exhibiting a log-linear dependence on vapor pressure.

Building on these observations, future work will examine how material porosity and paint type influence the transport and retention of smoke-derived VOCs. Depth-resolved measurements will further be used to characterize VOC distributions within the material and link these internal concentration profiles to emission rates and emission timescales.

10WF.3

Retention of Fire Smoke Pollutants in Soft Household Items Impacted by the 2025 Los Angeles Fires. HAOXUAN CHEN, Qiao Yu, Qiyue Nie, Priscilla Boo, Logan Umaguing, Annie Ding, Andy Liu, Jing Li, Muchuan Niu, Yuan Yao, Yifang Zhu, *University of California, Los Angeles*

The 2025 Los Angeles Fires (LA Fires) generated complex smoke mixtures containing both gas- and particle-phase pollutants that can infiltrate and persist in indoor environments long after the flames are extinguished. Ubiquitous soft household items, such as clothing, bedding, and plush toys, are of particular concern for retaining these pollutants due to their porous structure and high surface area. Once contaminated, these materials may contribute to prolonged, yet often overlooked, post-fire exposure through secondary processes such as offgassing and resuspension.

Following the LA Fires, we collected over 250 soft household items from 20 homes impacted by the Eaton and Palisades Fires, along with items from non-fire-impacted control homes. Offgassing chamber tests detected 15 volatile organic compounds (VOCs) associated with fire emissions with > 50% detection frequency across all items (e.g., 1-butene, acetic acid, and toluene). Among these compounds, acetic acid, a marker of biomass combustion, show significantly higher weight-normalized offgassing levels in items impacted by both Eaton and Palisades Fires compared to control items (1.7- and 2.2-fold increases, respectively, both adj-$P<0.01$). In contrast, hexane, a petroleum-derived hydrocarbon associated with synthetic materials combustion, was elevated only in Eaton fire-impacted homes (2.1-fold increase, adj-$P<0.01$). These results suggest differences in the dominant emission sources contributing to fire-related chemical retention in soft household items between the Eaton and Palisades fires. Ongoing studies also analyze surface dust on these soft household items to characterize particle deposition from the fire smoke and its relationship with VOC retention, as well as evaluating common cleaning methods (e.g., laundering and dry cleaning) for contaminant removal.

This study advances our understanding of the indoor fate of fire smoke pollutants and highlights the role of soft household items as secondary sources contributing to sustained exposure following WUI fires. These findings also provide data to inform evidence-based cleanup, remediation, and recovery strategies.

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10WF.4

Wildfire Smoke Preparedness Planning and Indoor Air Quality Interventions for Oregon's Schools. PARICHEHR SALIMIFARD, C. Victoria McCrary, Jalil Mokhtarian Mobarakeh, Lillian Moo, Meghan Megowan, Sara Jones, Perry Hystad, Molly Kile, *Oregon State University*

Exposure to wildfire and wildland-urban interface (WUI) smoke particulate matter (PM) is a major public health concern, particularly for children whose respiratory systems are still developing and who have higher ventilation rates relative to body size. In Oregon, increasing wildfire smoke events have raised concerns regarding indoor air quality (IAQ) in schools and childcare facilities, where children spend a significant portion of their time indoors. While portable air cleaners and filtration strategies can reduce indoor PM exposure, there remains a need for practical smoke preparedness planning and operational guidance tailored to educational buildings.

This project, supported by the U.S. EPA Wildfire Smoke Preparedness in Community Buildings Grant Program, focuses on developing and implementing smoke preparedness interventions for schools and childcare facilities across Oregon. The project integrates long-term indoor and outdoor air quality monitoring, deployment of portable air cleaners, development of smoke preparedness plans, and stakeholder engagement with school administrators, childcare providers, and public health partners. Monitoring has been conducted in multiple microenvironments within educational buildings exposed to wildfire and prescribed burn smoke events in southern Oregon.

Preliminary findings indicate that outdoor smoke events substantially impact indoor PM2.5 concentrations, with considerable variability observed among rooms within the same building. Differences in indoor-to-outdoor PM2.5 ratios suggest that ventilation strategies, building characteristics, filtration, and room operation can significantly influence smoke infiltration and indoor exposure levels. Initial implementation efforts also demonstrated the importance of integrating real-time IAQ monitoring with operational decision-making and staff preparedness during smoke events.

This presentation provides a high-level overview and update on this ongoing project, including intervention implementation, long-term monitoring efforts, and early lessons learned from smoke preparedness planning in educational settings. This work contributes to broader efforts to improve wildfire and WUI fire smoke exposure mitigation, building resilience, and healthy indoor environments for vulnerable populations during wildfire smoke events.

10WF.5

Are Portable Air Cleaners Operated When Needed? Time-Resolved Evidence from Preschool Classrooms During Wildfire Events. C. VICTORIA MCCRARY, Xiaosu Ding, Jalil Mokhtarian Mobarakeh, Caleb Rismiller, Lillian Moo, Meghan Megowan, Sara Jones, Perry Hystad, Molly Kile, Parichehr Salimifard, *Oregon State University*

During wildfire smoke events, particulate matter (PM) levels rise and infiltrate buildings where occupants could experience adverse health effects. Portable air cleaners (PACs) are a low-cost yet effective way to improve indoor air quality (IAQ) by reducing indoor PM concentrations through filtration. The nominal clean air delivery rate (CADR) of PACs is rated at their highest fan speed. However, higher fan speeds are reported to not always be used due to noise issues, especially at schools since it can disrupt student-teacher communication. Consequently, the presence of PACs alone does not indicate the level of PM mitigation it provides due to the occupant behavior factor. This study aims to investigate the impact of PAC operation, as controlled by school occupants, on the IAQ of a preschool in southern Oregon during wildfire and prescribed burn events. We conducted this study over a 12-month period spanning from April 2025 to 2026. Three rooms were chosen for analysis. Class 6 lacks ventilation but has a window air conditioning unit. Class 10 has mechanical ventilation, and the Staff Room has a mini-split system and heat recovery ventilation. Class 6 and Class 10 contain one PAC unlike the Staff Room. All rooms have a PurpleAir air sensor that monitors temperature, relative humidity, and PM concentrations in units of $\mu g/m^3$. Each PAC is connected to a HOBO plug load data logger which measures the power and energy consumption and can be used as an indicator of different PAC fan speeds and operation modes selected by occupants. Results showed that although higher fan speed settings were used during smoke events, lower speeds were more commonly used at other times. This study quantifies the correlations between PAC usage, indoor $PM_{2.5}$ concentrations, and indoor to outdoor ratios (I/O) during smoke and non-smoke events.

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10WF.6

Increasing Access to Comfortable and Healthy Indoor Air During Extreme Outdoor Events. DUSTIN POPPENDIECK, Nathan Lima, Jana Butman, Aika Davis, Ryan Falkenstein-Smith, Michael Link, Thomas Cleary, *National Institute of Standards and Technology*

Transient events (e.g., wildfire smoke) and sustained outdoor air pollution (e.g., urban smog) can degrade indoor air quality (IAQ). Occupants in residential buildings have limited options for improving IAQ, and typical “do-it-yourself” (DIY) recommendations include installing air cleaners and/or creating relatively sealed “cleaner air spaces” in a home. Although these recommendations have been shown to reduce indoor particulate matter concentrations, they face three common barriers: noise, cost/complexity, and thermal discomfort/practicality.

The objective of this effort is to characterize and evaluate simple, practical, DIY methods for reducing air contaminants for occupants of residential buildings. Specifically, this project sought to evaluate:

1) Temporary placement of fibrous materials on HVAC supply and return ducts.

2) The use of a window AC unit as a means to both maintain the thermal comfort of a “safer air space” and as a fan for a DIY particle removal effort.

To evaluate these intervention methods, we employed a field-scale contamination approach to introduce WUI fire smoke into the National Institute of Standards and Technology (NIST) IAQ test house. Each intervention was evaluated based on parameters such as thermal comfort, HVAC performance, noise, and effectiveness (particle reduction rate). In this presentation, preliminary data from these experiments will be discussed.

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11AC.1

PFAS in the Urban Atmosphere Detected with I-CIMS and LC-ESI Orbitrap Mass Spectrometer. Lee Tiszenkel, Vignesh Vasudevan Geetha, Zachary Watson, James Flynn, SHANHU LEE, *The University of Alabama in Huntsville*

Per- and polyfluoroalkyl substances (PFAS) are persistent atmospheric pollutants with significant health effects, but their atmospheric fate in urban areas remains poorly characterized due to limited measurements. For the first time, we combined non-targeted in-situ iodide chemical ionization mass spectrometry (I-CIMS) with targeted offline liquid chromatography electrospray ionization Orbitrap mass spectrometry (LC ESI-Orbitrap MS) based on EPA Method 1633 to detect and quantify 22 gas- and particle-phase atmospheric PFAS in Houston, Texas. We found total gas-phase ΣPFAS of 2.2 pptv (17.7 ng m-3) and particle-phase ΣPFAS of 1.1 pptv (12.5 ng m^{-3}). Perfluoropropionic acid (PFPrA) and trifluoroacetic acid (TFA) were the most abundant PFAS with peak concentrations reaching 3 to 6 parts per trillion by volume (pptv) in the gas-phase, among the highest reported across urban atmospheres. We calibrated I-CIMS for 18 PFAS, 9 for the first time, and validated I-CIMS against LC-ESI Orbitrap MS across 9 co-detected compounds. These validated measurements enabled the first simultaneous in-situ gas- and particle phase PFAS observations, revealing rapid partitioning dynamics: gas-phase PFAS concentrations correlated with ozone and temperature suggesting photochemistry and meteorology are relevant to atmospheric PFAS loadings, while particle-phase PFAS correlated with humidity, reflecting efficient uptake into aqueous aerosol with particle-associated fractions exceeding those previously reported in other cities. Comparison of Houston and Huntsville PFAS profiles revealed a strong influence of local emissions. PFCA abundance decreased with carbon chain length in Houston, but concentrations were completely inverted in Huntsville where long-chain PFCAs (C8-C12) predominated, likely due to nearby military and fluoropolymer manufacturing sources. Emerging PFECAs including DONA and GenX were detected in Houston but absent in Huntsville, highlighting the importance of broad compound coverage for characterizing urban PFAS. These results demonstrate that urban PFAS profiles and phase behavior vary with meteorology, photochemistry, and local sources, with implications for urban exposure assessment.

11AC.2

Online Gas- and Particle-Phase Speciation of Organic Aerosol Formation in Paris. Imad Zgheib, Milan Roska, Sebastien Perrier, Francois Gaie-Levrel, Laurent Gauvin, Mendosa Rabort, Urs Rohner, Felipe Lopez-Hilfiker, Georgios Gkatzelis, MATTHIEU RIVA, *CNRS-IRCELYON*

Online chemical characterization of atmospheric particles is often challenged by thermal decomposition, fragmentation, wall losses, ionization selectivity, and rapid changes in particle concentration and composition. To overcome these limitations, we developed the Wall-Free Particle Evaporator (WALL-E) coupled to a Vocus B4 chemical ionization mass spectrometer equipped with an Aim reactor and using iodide ion chemistry for molecular-level characterization of the particle phase. In parallel, gas-phase composition was retrieved using PTR-TOF-MS operated with NH4+ and H3O+ reagent ions, enabling complementary speciation of volatile and oxygenated organic compounds. Here we report the first ambient field deployment of this combined setup, conducted from mid-September to mid-October 2025 at the AIRPARIF background supersite in central Paris.

The resulting datasets resolve short-timescale variability alongside sustained background changes in both phases. To identify and quantify the main aerosol and gas-phase sources, we applied combined positive matrix factorization (cPMF) to the WALL-E–Vocus B4 particle-phase data and aerosol chemical speciation monitor (ACSM) data from the site, resolving distinct composition modes with characteristic temporal signatures. The retrieved factor profiles are further interpreted and validated against comprehensive laboratory observations performed under controlled conditions, providing a benchmark for source assignment and chemical interpretation.

A key outcome is the prominent contribution of cooking-related emissions, which emerge as a robust factor in primary organic aerosol with a clear diurnal cycle and diagnostic molecular fingerprints in both phases. We further resolve factors linked to daytime and nighttime monoterpene (MT) chemistry, captured across both gas- and particle-phase measurements, highlighting their role in secondary organic aerosol formation, and separate these from more persistent background and regional influences. This work delivers molecular-level fingerprints and quantitative constraints on the gas- and particle-phase composition of urban air in central Paris, advancing our understanding of POA sources and SOA formation pathways in a megacity environment.

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11AC.3

Integration of Oxidation Mechanisms of Phenolic Compounds Into CRACMM2. ABDULLAH ALTORKI, Myoseon Jang, *University of Florida*

Phenolic compounds (phenol, catechol, cresol, methylcatechol) are major components of wildfire and biomass burning emissions, yet their oxidation chemistry in condensed atmospheric mechanisms remains poorly evaluated. This study evaluates and corrects the treatment of phenolic oxidation in EPA's Community Regional Atmospheric Chemistry Multiphase Mechanism version 2 (CRACMM2), used within the CMAQ modeling system, by benchmarking against an explicit mechanism (XPT) validated with UF-APHOR dual outdoor smog chamber data processed through the DSMACC-UF box model framework. Four structural errors were identified in CRACMM2: (1) phenol + OH incorrectly producing methylcatechol instead of catechol, (2) missing catechol ring-opening chemistry, (3) absent catechol + O_3 reaction, and (4) a chemically impossible phenoxy radical reaction. A corrected mechanism comprising 76 XPT-grounded reactions and 22 new species was developed, incorporating explicit peroxy radical fates, catechoxy/methylcatechoxy catalytic ozonolysis cycles, and nitrocatechol/nitro-methylcatechol formation chains for all four phenolic compounds. For phenol daytime oxidation (HC/NOx = 10.7), the corrected mechanism reduced hydrocarbon consumption bias from −69% to −20% and reproduced the observed NO-to-NO_2 crossover timing, while peak ozone bias improved from −75% to +9% (104 vs. 95 ppb observed). For nighttime conditions, the corrected mechanism eliminated a 9 μg m^{-3} spurious aerosol artifact present in the original. The corrected gas-phase mechanism provides the chemical basis required for accurate prediction of secondary organic aerosol formation from phenolic precursors using absorptive partitioning models, addressing a critical gap in wildfire aerosol prediction.

11AC.4

Diurnal and Seasonal Dynamics in the Competition Between Atmospheric Oxidation and Deposition. SINA TAYYEBI NIA, Chenyang Bi, Gabriel Isaacman-VanWertz, *Virginia Tech*

Secondary organic aerosol (SOA) formation from volatile organic compounds (VOCs) depends in part on multi-generational oxidation that produces increasingly low-volatility products. This pathway implicitly requires that oxidation products persist in the atmosphere long enough to undergo further chemical processing and condense into the particle phase. However, dry deposition removes oxygenated VOCs (OVOCs) from the atmosphere before they can contribute to later-generation SOA formation, and the magnitude and timing of this loss across both diurnal and seasonal timescales remain poorly constrained. Using timescale-based frameworks for the fate of molecules, we evaluate how the competition between oxidation and deposition changes over the course of days and seasons. Though deposition velocity is highest during the day, this coincides with high oxidant concentrations, producing a tendency to oxidize during the day and deposit at night. However, there are significant uncertainties due to uncertainty in parameterizations used in common dry deposition schemes. Recent work has used decreased cuticular resistance to bring predicted and observed deposition velocities into agreement, but we demonstrate here that such an approach eliminates the observed and expected diurnal variability in deposition. Consequently, choices of current parameterizations appear to either underestimate daytime deposition or overestimate nighttime deposition. We show that parameterizations diverge most sharply in the intermediate-solubility regime often representative of lightly oxygenated compounds for which SOA formation is most sensitive to compound fate. These issues are found to be most critical in the summer, during which deposition and oxidation are generally competitive due to high oxidant concentrations, while deposition strongly limits multigenerational chemistry and aerosol formation in other seasons. These findings suggest that current deposition frameworks introduce systematic and time-varying biases in predicted fate and multigenerational chemistry. Improving deposition measurements for intermediate-solubility OVOCs, particularly at night and partitioned across each resistance term, is critical for accurately constraining aerosol burdens across seasons.

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11AC.5

Functional Groups with Online Aerosol Mass Spectrometry: OA Aging Processes and Properties. RACHEL O'BRIEN, Manjula Canagaratna, Xu He, Janie (Yeaseul) Kim, Willow Hwang, Hannah Kenagy, Christopher Cappa, *University of Michigan*

Organic aerosol (OA) contains thousands of different organic molecules which can transform in the atmosphere as a result of aging processes like photolysis and heterogeneous oxidation. Chemical properties like the average molecular weight and the functional group distribution of the mixture will impact the physical properties of the particles. Functional group distributions can be evaluated using methods like Fourier Transform Infrared Spectroscopy (FTIR), but this requires sample collection for offline analysis. Here, we have developed a novel method to quantify alkyl, aromatic, carboxylic acid, ketone, alcohol, and amine functional groups directly from High Resolution-Time of Flight-Aerosol Mass Spectrometer (HR-ToF-AMS) data sets. This method uses a grouping method termed delta analysis and we have applied this method to a wide range of AMS data sets. We find that chamber studies of OA photolysis show an increase in the acid fraction and a decrease in the alkyl portion without a corresponding decrease in ketones. This is in contrast to photolysis aging on a filter in a flushed box where a decrease in ketone is observed. This highlights the potential role of the reservoir of semi-volatile organic carbon compounds in the chamber, but not in the flushed box. We also find that the composition of highly oxidized OA from ambient measurements is about 50% acid and 25% alcohol, with only a small fraction of ketone. Finally, we find that biomass burning OA can show variations in functional group shifts with aging dependent on the initial mixture. Overall, our ability to quantify functional groups directly from online AMS data sets opens new doors for the analysis of OA formation and aging and it helps close the gap between ambient measurements and chamber studies. It also provides new methods to evaluate models for SOA formation and for physical properties of OA.

11AD.1

A Dust-Discriminating Smoke Detector Suitable for Lunar Missions. MARIT MEYER, Thorsten Schultze, Jan Balzer, *Amentum/NASA*

The spacecraft environment has many potential hazards that can lead to loss of mission or loss of life. Fire is once scenario that can quickly become catastrophic, so smoke detection is a critical function in any space vehicle or habitat. The current state-of-the-art smoke detectors on the International Space Station (ISS) are photometric, based on smoke particles scattering light, and therefore are prone to false alarms from nuisance dust. While the ISS generally has extremely low particle concentrations due to HEPA filtration, there are occasional localized spikes especially during housekeeping and vacuuming when dust is re-entrained into the air in the immediate vicinity. False alarms during crew cleaning became so frequent on ISS that an operational control was established to turn off smoke detectors for the duration of these activities. This is a reasonable approach for ISS, however, future lunar surface missions will have a new and ubiquitous nuisance aerosol, namely lunar dust. Ideally, the next generation of smoke detectors for lunar missions will have the ability to distinguish between smoke and lunar dust and have uninterrupted operation. A terrestrial optical smoke detector with this capability has been tested and implemented in dusty environments and can be adapted for space applications. The smoke detector differentiates aerosols based on the polarimetric properties of scattered light. Polarimetric light scattering measurements with lunar simulants and with mixed dust and smoke aerosol will be presented along with special considerations for dust-tolerant designs and hardware needs for space missions.

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11AD.2

Extracting Lunar Simulant Size Distributions from Opera's Multi-Channel, Multi-Wavelength Sensor Data. DMITRI CHILDS, Sreekesh Kookkal, Marit Meyer, Suresh Dhaniyala, *Clarkson University*

The OPto-Electrical Real-time Aerosol Spectrometer (OPERA) is a new, compact, low-cost sensor that operates on focused light scattering (FLS) technique. The OPERA measures particle scattering intensities at multiple scattering angles at two illumination wavelengths. The OPERA also provides electrical-mobility related measurements, but that signal is not analyzed in this study. The real-time OPERA signal provides a real-time particle feature set of 12 measurements of pulse heights and pulse widths. As the data set is generated by particles intersecting the laser beam at a range of intensities and scattering angles, the inversion of this data set can be complicated. Here, we experimentally obtain OPERA signal data for a range of monodisperse and polydisperse size distributions of different lunar simulants. The OPERA size distributions calculated using different inversion techniques are compared against those obtained by reference instruments - ELPI+ and APS. We will present the different approaches used and highlight the most robust algorithm for inversion of this complex data set.

11AD.3

Aerosols and Clouds in the Transient Lunar Atmosphere. ALEXANDRIA JOHNSON, Eli Hueston, Rowan Nag, *Purdue University*

While devoid of one today, studies suggest that 3.5 Ga the Moon may have supported an atmosphere with a surface pressure comparable with that of current day Mars. Forming through magmatic degassing, and mainly composed of carbon monoxide, sulfur, and water, this transient but collisional (0.9 kPa) atmosphere could have taken 70 Myr to dissipate and may have been prolonged by the protection of a strong, lunar magnetic field. Although, the amount of outgassing and longevity of this transient atmosphere has been debated, understanding its impact is of critical importance for investigating volatile transport, deposition, and loss in the lunar system and beyond. These studies can also provide insight into in situ resources for future human based missions to the moon, provide understanding of the transient atmospheres of small bodies, and enhance current day and past cloud aerosol interactions on Earth.

The work presented here investigates the transient lunar atmosphere using a twofold approach. First, we use a simple, 1-D atmospheric model to constrain the temperature, pressure, and chemical composition of the lunar atmosphere. Given the uncertainty in atmospheric parameters we have chosen to consider a wide range of proposed surface conditions across the literature and their impacts on establishing an equilibrium state. Second, we conduct laboratory studies on the immersion freezing properties of lunar regolith simulants with a droplet freezing assay. While water is the first volatile of interest, findings from our chemical equilibrium model will be used to identify additional volatile species for nucleation and cloud processes. If time presents itself, we look forward to using our findings to help understand atmospheric circulations and the ability of the lunar atmosphere to transport, deposit, and store volatiles across the astronomical body.

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11AD.4
Modeling and Source Attribution of Fugitive Dust at the Oceano Dunes. EDEN FURTAK-COLE, *Desert Research Institute*

Oceano Dunes, on California's central coast, comprises extensive coastal dune fields adjacent to beach, lagoon, and agricultural lands. Formed by persistent onshore winds, the dunes host shifting ridges, interdunal wetlands, invasive species, and remnant native vegetation interspersed with unvegetated blowouts. Historical land uses, including beach recreation, off-highway vehicle access, and localized grading, have altered surface stability, landforms, and vegetation patterns. Seasonal wind regimes, episodic storms, and dry seasonal conditions interacting with the land surface frequently cause both state and federal PM10 air quality violations.

Computational fluid dynamics is combined with atmospheric measurements and high resolution topographic data to investigate the shear stresses, and resulting emissions, on the surface of various landforms at Oceano Dunes, CA. This approach allows for paired simulations over measured and digitally modified topographies using the same boundary condition. The simulation domains include a vegetated foredune, non-vegetated transverse dunes, a restoration area, and a disrupted area. Shear values from scenarios that account for the effects of vegetation and aerodynamic form separately are presented. Simulations are performed on an unmodified topography, a topography with the foredune flattened, and a topography with a flat surface in the lee of the foredune. Results from these hypothetical scenarios aid in predicting the air quality impacts of changing land management practices. Using available dust emission relations for sand from this area, emissions was calculated for each simulated scenario. Vegetation is shown to have important effects on the surface shear and emissions though it covers only approximately 13% of the surface.

11AD.5
Trace Metal-Containing Aerosols in the Atmosphere of the Southern Indian Ocean. Johannes Passig, Aleksandrs Kalamasnikovs, HASEEB HAKKIM, Sven Ehlert, Andreas Walte, Nicole Riemer, Eric Achterberg, Ralf Zimmermann, *University of Rostock*

Atmospheric aerosol deposition represents a major source of iron and other micronutrients to remote ocean regions, where nutrient limitation constrains primary productivity, marine ecosystem dynamics, and carbon sequestration. However, large uncertainties remain due to sparse observational data and the limited availability of highly sensitive techniques capable of resolving transition metals at low aerosol loadings. Here, we present first results from a shipborne campaign conducted aboard RV Sonne across the Indian Ocean in late 2024 within the framework of GEOTRACES.

Aerosol particles were analyzed using a novel single-particle mass spectrometer (SPMS) employing resonant laser ionization, enabling the chemical characterization of several hundred thousand individual particles. Although sea spray aerosol dominated the overall particle population, thousands of iron-containing particles were detected, primarily associated with long-range transported mineral dust. Several percent of these particles consisted of internal mixtures of sea spray and mineral dust, highlighting the importance of repeated cloud processing during atmospheric transport. In addition, a subset of sea spray particles exhibited distinct iron signatures, suggesting in-cloud mixing and enhanced iron mobility through heterogeneous processing.

For mineral dust particles, nitrate represented the dominant secondary component, even in air masses that had remained isolated from continental influence for more than ten days. Elevated iron contents frequently coincided with the presence of dicarboxylic acids, whereas Mg/Ca-rich particles were preferentially associated with sulfate, indicating distinct atmospheric aging pathways, transport histories, and likely differences in iron solubility. These observations reveal an unexpectedly high abundance and chemical diversity of iron-containing aerosols over the Indian Ocean and underscore their potential importance for marine biogeochemistry and nutrient cycling in this still sparsely characterized region.

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11CA.1

Automated Aerosol Type Classification Using a 2D Absorption Ångström Exponent Framework and Unsupervised Learning Based on AE36s 9λ Absorption Measurements. Asta Gregorič, Matic Ivančič, Irena Ježek Brecelj, Bálint Alföldy, MARTIN RIGLER, *Aerosol d.o.o.*

Light-absorbing aerosols (LAA) are a major source of uncertainty in radiative forcing due to changes in their optical properties with aging and mixing state. Multi-wavelength absorption measurements provide valuable spectral information for aerosol typing, yet conventional single–Ångström exponent approaches often fail to resolve complex mixtures. A two-dimensional absorption Ångström exponent (2D AAE) framework based on 9 wavelength Aethalometer AE36s measurements was previously introduced to address this limitation by exploiting spectral information across the UV–near IR range [1].

The 2D AAE framework combines AAE determined in two wavelength ranges ($AAE_{400\text{-}590}$, $AAE_{590\text{-}950}$) with UV absorption deviations (Δ_{340}, Δ_{370}) to capture characteristic absorption fingerprints. In this study, the framework is extended using unsupervised machine learning techniques to enable automated aerosol classification. Several clustering algorithms were applied to ambient AE36s datasets. Two feature configurations were evaluated: (1) parameters derived solely from the AE36s, including AAE values, UV deviations, and the loading compensation factor k(λ); and (2) an augmented set incorporating co measured quantities, namely the organic carbon to equivalent black carbon ratio (OC/eBC) obtained from a Total Carbon Analyzer (TCA08) [2] and co located PM_{10} mass concentrations.

Across clustering methods and feature sets, the analysis consistently yielded reproducible and physically interpretable aerosol classes. The automated classification reproduces previously identified aerosol types - such as fresh and aged black carbon, residential and open biomass burning, and mineral dust - while providing additional insight into aging state and mixing. The results demonstrate a robust, near real time workflow for LAA type identification using routine absorption measurements.

References:
[1] Gregorič et al., in review, 2026.
[2] Rigler et al. Atmos. Meas. Tech., 2020.

11CA.2

Fluorophoric Composition of Brown Carbon Aerosols over the Megacity of India. Swati Joshi, ATINDERPAL SINGH, Chandrima Shaw, Garima Verma, Neeraj Rastogi, *University of Delhi, India*

Brown Carbon (BrC) has recently emerged as a light-absorbing fraction of organic carbon (OC), especially in the shorter wavelength region (UV-Visible), influencing both atmospheric radiation balance and air quality. Despite growing attention over the past decade, uncertainties remain regarding its climate implications due to its complex composition, diverse sources, and scarcity of regional observations. BrC, particularly its water-soluble fraction (BrCaq), is a significant component of OC over the Indo-Gangetic Plain (IGP), a region considered as hotspot of pollution due to high emissions from biomass burning, fossil fuel use, residential heating, and unique topography. Within this context, the present study characterizes BrCaq across the Delhi region during the winter season, with a focus on diurnal variability. The optical properties of BrCaq were evaluated through parameters such as the light absorption coefficient (babs), Absorption Ångström Exponent (AÅE), and Mass Absorption Efficiency (MAE) at 365 nm. The observed average values were 19 ± 12 Mm^{-1}, 6.5 ± 1.60, and 0.9 ± 0.4 $m^2\ g^{-1}$, respectively. Radiative effects were assessed using relative radiative forcing (RRF), which showed that BrCaq contributes around 44.4 ± 20% in the 300–700 nm band compared to elemental carbon (EC). Furthermore, Excitation–Emission Matrix (EEM) fluorescence spectroscopy, along with parallel factor analysis (PARAFAC) approach, was applied to identify major fluorophores like humic-like substances (HULIS) and protein-like substances (PRLIS). Moreover, regression analysis revealed that the HULIS fraction primarily drives the light-absorption properties of BrCaq during winter. The results reveal clear diurnal contrasts, with higher BrC absorption during night-time driven by biomass burning and residential heating emissions, along with stagnant meteorological conditions. Overall, this study provides useful insights into the optical behavior and chemical nature of BrCaq in Delhi, helping to better constrain its role in regional climate processes over the IGP.

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11CA.3

Enriched Brown Carbon and Rapid Aging in Wildfire Smoke Revealed by a Carbonaceous Aerosol Speciation System. L.-W. ANTONY CHEN, Olusanya Onamuti, *University of Nevada, Las Vegas*

Brown carbon (BrC) exhibits highly variable optical properties associated with source composition, atmospheric processing, and photochemical aging, yet most BrC quantification approaches still rely on fixed BrC absorption profiles or prescribed spectral relationships. Recently, an enhanced spectral/mass balance receptor-modeling framework was developed to resolve black carbon (BC), BrC, and non-absorbing white carbon (WtC) while allowing sample-specific variation in BrC optical properties within the U.S. Chemical Speciation Network (CSN). By coupling total carbon (TC) measurements with multiwavelength aerosol light absorption, the framework enables simultaneous estimation of BrC mass fraction, absorption Ångström exponent (AAE), and mass absorption efficiency (MAE) without prescribing a BrC spectral profile. In this study, we present the first application of this framework to continuous TC and light absorption measurements at seven wavelengths (370–950 nm) from a Carbonaceous Aerosol Speciation System (CASS) deployed at the University of Nevada, Las Vegas air quality monitoring station. Hourly absorption spectra were mapped onto the canonical CSN wavelength grid for the analysis, which successfully resolved dynamic BrC abundance and optical properties throughout the July 2025–January 2026 monitoring period. During the August 2025 Gifford Fire smoke episode impacting Las Vegas, aerosol composition shifted rapidly from WtC-dominated urban aerosol to BrC-enriched smoke conditions. Most hourly BrC AAE values ranged between 3 and 4, while BrC MAE at 520 nm was primarily between 1 and 2 m^2 g^{-1}, characteristic of moderately to strongly absorbing BrC. While BC contributions remained relatively stable, declining BrC/BC ratio and AAE following peak smoke influence suggested rapid photobleaching and transformation of absorbing BrC into weakly absorbing or non-absorbing organic aerosol on timescales of hours. These preliminary results demonstrate the capability of continuous CASS measurements combined with enhanced spectral/mass balance modeling to provide valuable insights into BrC evolution and atmospheric aging from diurnal to seasonal time scales.

11CA.4

Quantifying Brown Carbon Absorbance from PM2.5 Filter Samples via Digital Imaging. RAFAEL BRAGA GOMES, Maisha Agarwal, Annika Khurana, Tracy Lu, Kyan Shlipak, Sina Hasheminassab, Olga Kalashnikova, Albert Presto, *Carnegie Mellon University*

Brown Carbon (BrC) is the light-absorbing organic component of fine particulate matter ($PM_{2.5}$) primarily emitted from biomass and coal burning. It can also form through atmospheric chemical reactions. Due to its complexity, BrC is a poorly understood climate-forcing agent, as continuous ground-truth measurements are not only costly but also lack a universally standardized methodology, thereby severely limiting data availability. This research introduces a novel, low-cost digital imaging technique to quantify primary BrC absorbance directly from archived hourly $PM_{2.5}$ filter tapes collected by Beta Attenuation Monitors (BAMs) deployed at U.S. Embassies worldwide. The optical model was developed using a combination of ambient samples collected in Pittsburgh, PA, and controlled laboratory sampling of emissions from a woodstove and a diesel generator. These emissions first passed through a Dekati diluter and then into a Teflon smog chamber, where they were co-sampled with an Aethalometer (AE33) and onto filter samples. By analyzing spectral attenuation across the digital camera's RGB channels, we developed a method that isolates the BrC absorbance from Black Carbon absorption. This laboratory-derived method was subsequently applied to ambient BAM samples and contrasted against a research-grade, co-located microAethalometer (MA350) across multiple seasons at two contrasting sites in Addis Ababa, Ethiopia. The camera-derived measurements captured diurnal temporal features that closely tracked those of the reference aethalometer, including site and season-specific BrC absorption profiles. Ultimately, translating this optical model from the lab to the field enables retrospective and continuous hourly monitoring of BrC across global BAM networks, yielding ground-truth data to support the calibration and validation of aerosol remote sensing products from satellite missions such as MAIA and DSCOVR EPIC.

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11CA.5

Using Non-Target Analysis to Derive Novel Formation Pathways to Secondary Brown Carbon from Biomass Burning Carbonyls in Aerosol Liquid Water. RHIANNA EVANS, Angelina Petersen, Tran Nguyen, *University of California, Davis*

Brown carbon (BrC) is a complex mixture of light-absorbing compounds in atmospheric aerosol that strongly absorb in the near-ultraviolet and visible region of the electromagnetic spectrum resulting in a positive radiative forcing effect on Earth's climate. However, the overall magnitude of the BrC radiative forcing effect is still highly uncertain and remains a challenge in predicting future climate change. Whilst the major source of atmospheric BrC is from primary emissions such as biomass burning, secondary production of BrC in aerosol liquid water remains an important contribution. However, few chemical mechanisms for secondary brown carbon (sBrC) formation have been described in the literature and largely pertain to small carbonyls such as glyoxal indicating a greater scope of atmospheric species is needed. In this work, sBrC was shown to form when high ionic strength salts were mixed with biomass burning derived organics under irradiated conditions. Non-target high-resolution mass spectrometry and spectroscopic techniques were used to identify the sBrC composition from photochemical reactions of 3,4-dimethoxybenzaldehye (DMB), a major emission from biomass burning (5-23 mg/kg) and triplet carbon precursor. We discuss mechanistic formation pathways to sBrC from various salt matrices, and show the presence of ammonium salt enhances the absorbance and chemical complexity of sBrC.

11CM.1

Evaluating HVAC Filtration Performance for Biological Aerosols Under Occupied Conditions. DAVID KORMOS, Rafsan Nahian, Michelle Wu, Sarah Haines, Jeffrey Siegel, *University of Toronto*

Filtration performance in buildings is typically evaluated using particle mass– and number–based metrics such as efficiency, airflow, and pressure drop. While these metrics are informative for general aerosol control, they do not fully characterize the behavior of biologically derived aerosols, which differ in source dynamics, size distributions, and removal mechanisms. This work seeks to integrate molecular bioaerosol measurements into conventional aerosol evaluation frameworks to better understand filtration performance under real occupied conditions. Bioaerosol sampling was conducted in four high-occupancy classroom environments during the winter. Long-duration air sampling was performed during typical occupied hours under six filtration conditions, including five HVAC filter and room air-cleaning configurations spanning a range of efficiencies and a zero-filter screen baseline. Total airborne bacterial material was quantified using quantitative polymerase chain reaction (qPCR) targeting the 16S rRNA gene and normalized by sampled air volume. Biological concentrations were evaluated alongside concurrently measured $PM_{2.5}$, CO_2, and HVAC system parameters. Viral and specific bacterial targets, including influenza and SARS-CoV-2, are currently being quantified with dPCR. Results show that higher-efficiency filters meaningfully reduce airborne bacterial concentrations across sites when compared to the zero-filter. Lower-efficiency filters were associated with substantially greater variability in bacterial concentrations, indicating increased sensitivity to occupancy and operating conditions, as reflected by CO_2. Particle and bacterial reductions were generally related, though the relationship was not linear, indicating some distinct source and removal constraints for biological aerosols. High-efficiency room air cleaning systems demonstrated stronger biological reductions than would be predicted by PM performance alone, suggesting the importance of source proximity. This study aims to establish a scalable framework for incorporating biological aerosols into filtration assessment and to advance understanding of how particle-based metrics relate to bioaerosol control in occupied indoor environments.

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11CM.2

Quantifying Airborne Microbe Inactivation Rates by Far-UVC, One Droplet at a Time. Robert Alexander, Xia Yi, Kennedy Peek, Tristan Cogan, Jamie Mann, Darryl Hill, Adam Finn, Andrew Davidson, JONATHAN P. REID, Allen E. Haddrell, *University of Bristol*

Far-UVC radiation (222 nm) is highly effective at inactivating airborne bacteria and viruses while exhibiting minimal penetration into human skin and eyes, enabling its potential use for disinfection in occupied spaces. However, there is currently no standardised method to quantify far-UVC inactivation kinetics of airborne microorganisms at the single-particle level.

To address this, we employ QELEBS (Quadrupole Electrodynamic Levitation and Extraction of Bioaerosol onto a Substrate), a system developed at the University of Bristol that enables controlled levitation of individual microbe-laden aerosol particles under defined environmental conditions (e.g., relative humidity and gas composition). Particles are irradiated with 222 nm far-UVC from a KrCl excimer lamp for 15–90 s and subsequently extracted for viability analysis. All particles are held at a fixed distance (125 mm) from the source to ensure uniform fluence.

Using this platform, we quantify far-UVC inactivation of Streptococcus pyogenes and Influenza A virus in respiratory fluid surrogates (growth media and artificial saliva). We observe an RH-dependent reduction in S. pyogenes viability (75% inactivation) after 90 s of irradiation and >99% reduction in Influenza A after 60 s. RH exhibited an inverse effect on inactivation for bacteria and viruses, consistent with different underlying biological decay mechanisms. Due to absorption of far-UVC by biological components in the aerosol, we hypothesise that a secondary inactivation pathway exists in addition to direct UV-mediated microbial damage. Localised energy deposition within the droplet may generate reactive species that contribute to microbial inactivation.

A unique aspect of this study is the ability to initiate irradiation at different stages of the aerosol lifecycle, enabling direct assessment of aerosol aging effects on disinfection efficacy. These results provide new insight into the roles of aerosol composition and environmental conditions in far-UVC performance and will inform models and the design of far-UVC systems for mitigating airborne disease transmission.

11CM.3

Glycol Vapors in Emergency Airborne Pathogen Transmission Suppression. DARRYL ANGEL, Brian Renda, Steve Martin, Aman Patel, Richard Williamson, Jacob Swett, *Blueprint Biosecurity*

Air disinfection technologies that can be rapidly and broadly deployed during pathogen outbreaks represent a critical gap in pandemic preparedness. Though existing measures, including ventilation, filtration, and germicidal UV, can reduce airborne disease transmission in shared spaces, their emergency use is constrained by cost, energy, deployment speed, or scalability (Lerner et al., 2025). Propylene (PG), dipropylene (DPG), and triethylene (TEG) glycol vapors present a promising alternative for transmission suppression in occupied spaces.

Our objective was to comprehensively evaluate the potential of glycol vapors as emergency airborne transmission countermeasures to inform preparedness strategies. Glycol vapors have demonstrated rapid inactivation efficacy among diverse pathogens including bacteria, viruses, and fungal spores (Mellody & Bigg, 1946; Robertson et al., 1942; Styles et al., 2023). While variation exists among controlled chamber studies, there is evidence that glycol vapors can optimally achieve ~3-6 log reductions/hour against bioaerosols under optimal environmental conditions (Robertson et al., 1942; Sultan et al., 2024). Historical field trials have reported effective glycol-mediated disease transmission suppression, including a 63-95% decrease in respiratory infections when PG or TEG vapors were deployed in a convalescent ward while non-airborne routes of transmission were controlled (Harris & Stokes, 1945). Limited adverse effects have been reported following PG, DPG, or TEG exposure, with safety assessments indicating negligible to low toxicity for healthy adults within efficacious concentrations (U.S. EPA, 2017). Furthermore, protecting indoor spaces with glycol vapors is inexpensive compared to other technologies (Lerner et al., 2025).

We identified knowledge gaps including deployment feasibility using commonly available dispersion methods, safety among potentially sensitive populations, and interactions with filtration media, which we are actively funding. The convergence of inactivation efficacy, safety profiles, and potential rapid deployment position glycol vapors as a promising pandemic preparedness strategy, while our research initiative addresses remaining questions to enable evidence-based deployment evaluation for emergency use.

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11CM.4

Advancing Bioaerosol Efficacy Test Methods for Air Treatment Technologies. KATHERINE RATLIFF, *U.S. Environmental Protection Agency*

An increasing focus on improving indoor air quality has resulted in growing attention on air cleaning and treatment technologies, which can be used to reduce airborne contaminant concentrations. In developing strategies for reducing the risk of disease transmission, decision makers have been particularly interested in technologies that can reduce concentrations of infectious aerosols. There are a wide range of these types of engineering controls, including those that capture and remove aerosols from the air (e.g., filtration, electrostatic precipitators), and those that inactivate microorganisms (e.g., UVC, chemical air treatments). The efficacy of these technologies has been evaluated using varied test methods, and they are often tested under ideal laboratory conditions, making it challenging to compare results across studies and predict real-world performance. Although several new consensus standards for evaluating technology efficacy have been published in recent years, these standards leave room for differences in testing approaches that can significantly impact efficacy. As new public-health-driven indoor air quality standards and clean air delivery targets emerge (e.g., ASHRAE Standard 241, *Control of Infectious Aerosols*), improving the comparability of testing results and confidence that the findings translate to application settings is critical. To address these challenges and improve the robustness of test methods, the U.S. Environmental Protection Agency has been conducting systematic bioaerosol experiments to understand how methodological changes can impact performance of different air treatment technologies. Results have shown that simple changes to methods, including changing the aerosolization medium or chamber size, can notably impact technology performance. This presentation will provide an overview of recent findings that are advancing efficacy test methods and highlight key knowledge gaps that remain.

11CM.5

Indoor Air Quality Intervention Using DIY Filtration and Environmental Genomic Analysis of Airborne Respiratory Viruses in School Classrooms. PRADEEP KUMAR, Misti Zamora, Hannah Cooke, Marina Creed, Kristina Wagstrom, Jessica Hollenbach, *University of Connecticut Health Center*

Airborne transmission of respiratory viruses in densely occupied indoor school environments remains a critical and insufficiently monitored pathway for disease spread. While the physical performance of Corsi–Rosenthal Boxes (CR Boxes), low-cost DIY air purifiers, is well characterized with respect to clean air delivery rates (CADR), their utility as bioaerosol collection platforms remains largely unexplored. This study evaluates CR Boxes as high-volume passive samplers for monitoring airborne viral loads in occupied school classrooms. Dust accumulated on deployed CR Box filters in public school classrooms was vacuum-collected and nuclease-treated to reduce extracellular nucleic acids prior to analysis. Viral RNA was extracted, and sequencing libraries were prepared and analyzed using the Oxford Nanopore platform to enable untargeted viral detection. Complementary PCR-based assays are being employed for targeted validation of clinically relevant respiratory pathogens, including SARS-CoV-2, influenza viruses, and RSV. Preliminary qRT-PCR analyses indicate low-biomass detection of SARS-CoV-2 signatures in filter-derived dust samples. By treating CR Boxes as passive bioaerosol samplers, this approach enables direct molecular interrogation of pathogen capture under real-world indoor conditions. Ongoing analyses aim to characterize viral signatures associated with classroom occupancy and evaluate the utility of CR Boxes as both exposure mitigation tools and environmental surveillance platforms. This presentation will discuss optimization of viral RNA recovery and sequencing workflows from filter dust, alongside emerging evidence supporting the use of existing air-cleaning infrastructure for real-world bioaerosol surveillance in school environments.

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11HR.1

Tracing Particulate Matter and Reactive Atmospheric Species Formation and Fate Inside the Respiratory and Circulatory System. ELENI DOVROU, *University of Crete*

Wildfire events present a rising frequency in recent years, especially in regions dominated by elevated temperatures, dry and windy conditions. During such events, the generated fire plume contains a mixture of gaseous and particulate species, driving the chemical processing during the initial and aging stage and generating a hazardous mixture for living organisms. Reactive species, such as peroxides, along with high particulate loadings near the fire-affected zones can be directly inhaled and participate in reactions within the respiratory, cardiovascular and nervous system.

In this work we evaluate the effect of these pollutants and their major secondary products formed in the inhaled air on the human respiratory, circulatory and nervous system. The interconnection between inhaled air and the trachea, lungs, circulatory and nervous system is simulated using an initial box model approach followed by direct coupling framework. Data obtained from recent wildfire events, specifically Greece 2023 and Los Angeles 2025, representing varying fuel types and seasonal conditions were analyzed and incorporated as input parameters into the newly developed model. The interactions of inhaled species and potential formation of aqueous-phase products were examined, revealing elevated levels of reactive oxygen species and organosulfates in the respiratory and circulatory systems. Summer fire events showed a 40-70% increase in reactive species production within the examined systems, with stronger impacts observed in children.

These findings highlight the importance of investigating seasonal differences (summer vs winter) and the role of vegetation type as fuel in shaping pollutant toxicity. Such understanding is essential for identifying the species posing higher risk and for developing targeted protective and mitigation strategies.

11HR.2

Comparing the Toxicological Effects of Primary and Aged Logwood Stove Emissions on Human Alveolar Cells Exposed at the Air-Liquid Interface. Aurelia Alunni, Emeline Barbier, Nour Jaber, Yamina Allouche, Ali Hnaino, Serge Collet, Jean-Pascal Meneboo, Martin Figeac, Brice Temime-Roussel, Barbara D'Anna, Gaëlle Uzu, Antje Biesemeier, Anthony Verdin, Guillaume Garçon, ALEXANDRE ALBINET, WOODNIGHT/WOODTOX-ALI Team, *INERIS*

Residential wood combustion is a major source of $PM_{2.5}$ in winter. It also emits significant quantities of volatile organic compounds which lead to the formation of secondary organic aerosols (SOA) through atmospheric (photo-)oxidation processes. The toxicological effects of wood combustion emissions, especially those of secondary emissions, are still not well understood. Air-liquid interface (ALI) exposure offers a physiologically relevant method for studying aerosol effects. This study aims to compare the pulmonary toxicity of primary and secondary (aged) emissions from a logwood stove. Experiments were conducted using a mixture of hardwood species (beech, oak, and hornbeam) and simulating real-world combustion conditions. The diluted emissions were aged using a Potential Aerosol Mass-Oxidation Flow Reactor (PAM-OFR) under daytime (OH radicals) and nighttime (NO_3 radicals) conditions. A comprehensive physicochemical characterization of gaseous and PM phases was conducted alongside an extended analysis of toxic species (metals, PAHs, nitro- and oxy-PAHs, nitrophenols, carbonyls) and PM oxidative potential. A coculture of human alveolar epithelial cells (hAELVi/A549 cell lines) was simultaneously exposed for the combustion duration (7-8 hours) to primary and aged emissions using two ALI CULTEX systems. Air control exposures were conducted using two Vitrocell ALI modules with filtered ambient air. Analyses by transmission microscopy/ion mass spectrometry provided information on the morphology and chemical composition of the PM within the cells. Biological responses were assessed by measuring cytotoxicity (LDH), metabolism (Resazurin), and inflammatory cytokines. Protein and DNA fractions were extracted using RIPA buffer and DNA/RNA/protein isolation kit to evaluate oxidative damage to macromolecules. Deregulated cell signaling pathways (3'-RNAseq) were investigated to determine specific markers of toxicity of primary and aged emissions. A comparative analysis of biological responses to both emission types, under both day- and night-time conditions, will be presented and discussed, providing critical insights into the toxicological impacts of wood combustion emissions and their aging processes.

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11HR.3

Effects of Atmospheric Aging on the Respiratory Toxicity of Polystyrene Nanoplastics Particles. Alana Dodero, Olivia Lampe, Sahir Gagan, Sining Niu, Natalie Johnson, YUE ZHANG, *Texas A&M University*

Inhalation exposure of nanoplastics particles (NPPs) can lead to significant pulmonary toxicity, however the effects of environmental processing on their toxicity remain poorly understood. This study examines the toxicity of polystyrene (PS) NPPs on lung cells following a selected range of atmospheric aging. Human bronchial epithelial cells (16HBE) were cultured in vitro at the air-liquid interface and acutely exposed to oxidized PS NPPs through electrostatic precipitation. Expression of proinflammatory genes Il-8 and Tnf-a was significantly elevated at 6 and 48 hours post-exposure to aged NPPs, with corresponding increases in IL-6 protein levels confirming the inflammatory response. The oxidative stress marker Ho-1 also showed significantly increased expression at 6 hours post-exposure, supported by protein analysis. Atomic force microscope (AFM) and aerosol mass spectrometry (AMS) revealed increased surface roughness and oxygenated functional groups in the atmospherically aged NPPs. Together, these results demonstrate that atmospheric aging alters the chemical composition and surface morphology of PS NPPs, enhancing proinflammatory and oxidative stress responses in bronchial epithelium cells, highlighting the critical role of environmental processing in determining the toxicity of nanoplastics.

11HR.4

Dose-Dependent Increases in Airway Resistance Following Secondhand E-Cigarette Aerosol Exposure in Vape Shops. SIRI LANGMO, Haoxuan Chen, Karah Lee, Muchuan Niu, Logan Umaguing, Yifang Zhu, *University of California, Los Angeles*

Electronic cigarettes have become increasingly prevalent in the United States, yet the respiratory effects of secondhand e-cig exposure remain poorly characterized. Vape shops represent a widespread indoor environment where vaping occurs in the presence of employees and customers. Prior research from our laboratory demonstrated that vaping density is strongly associated with fine particulate matter ($PM_{2.5}$) concentrations in vape shops, supporting $PM_{2.5}$ concentration as a field-based exposure metric. Forty-six healthy non-e-cig users, between 18 and 45, without diagnosed respiratory disease, were recruited to spend 6 hours in one of two commercial vape shops on separate occasions. Exposure conditions were characterized using observational notes and real-time $PM_{2.5}$ monitoring. Airway mechanics were assessed by Impulse Oscillometry before and after the vape shop visit, and again the following day. Mixed linear regression models were used to evaluate the associations between $PM_{2.5}$ concentration and changes in airway mechanics. Results demonstrated an exposure-dependent association between secondhand e-cig aerosol exposure and altered airway mechanics. The average $PM_{2.5}$ concentrations during participants' visits to vape shops ranged from 1.5 to 51 $\mu g/m^3$, and maximum concentrations ranged from 5.3 to 10,000 $\mu g/m^3$. Higher $PM_{2.5}$ concentrations were associated with increased total airway resistance (β= 0.197 per 10 $\mu g/m^3$, 95% CI 0.098-0.297, $p<0.001$) post vape shop exposure and the following day (β= 0.165 per 10 $\mu g/m^3$, 95% CI 0.079-0.251, p=0.001). These findings demonstrate that acute exposure to secondhand e-cig aerosol in commercial vape shops correlates with exposure-dependent changes in airway mechanics. To our knowledge, this is among the first studies to examine a dose-response relationship between real-world secondhand e-cig aerosol exposure and acute alterations in airway mechanics, showing potential respiratory risks for bystanders and vape shop employees.

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11HR.5

From In Vivo to In Vitro: Alzheimer's Disease Risk from Exposure to Different Particulate Matter Constituents.
YUEZHI (AUGUST) LI, Joseph V. Puthussery, Keyao Song, Nathan McFarland, Shu-Wen You, Jessica Restivo, John Cirrito, Rajan K. Chakrabarty, *Washington University in St. Louis*

Dementia affects over 55 million individuals worldwide, with Alzheimer's disease (AD) being the leading cause. Recent studies have provided increasing evidence for association between particulate matter (PM) exposure and AD development, emphasizing the importance of identifying neurotoxic PM constituents and their mechanisms.

This study investigates the neurotoxicity of different $PM_{2.5}$ constituents by examining their effects on neuronal cell viability. Representative PM components from urban, agricultural, and natural emission sources, including sulfates, nitrates, ammonium salts, transition metal compounds, dust, black carbon (BC), and organic matter, were evaluated using mouse-derived Neuro-2a (N2a) cells. The cells were exposed to graded concentrations of individual PM components for 24 hours to determine the lethal concentration causing 50% cell death (LC_{50}).

The tested PM constituents exhibited a wide range of neurotoxicity. Copper oxide (CuO), a pollutant associated with vehicular brake emissions, showed an LC_{50} of 13.1 μg/mL, whereas 9,10-phenanthrenequinone, a diesel combustion product, showed the lowest LC_{50} of 0.33 μg/mL among all selected pollutants. Notably, the water-soluble copper sulfate had a higher LC_{50} (40.1 μg/mL) than its insoluble counterpart, CuO, suggesting that soluble and insoluble compounds sharing the same cation can induce distinct neurotoxic response, possible through different neuronal degeneration mechanisms.

In parallel, we also conducted in vivo experiment by exposing mice to CuO and wildfire organic aerosols (WFOA) in a custom-built chamber. The microdialysis probe sampled interstitial fluid for subsequent analysis on the variation in soluble amyloid-beta (Aβ) peptide monomers, a pathological hallmark of early AD onset in the mice brain. WFOA exposure induced an immediate but transient increase in Aβ, with female mice exhibiting ~75% greater elevation than males after the initial exposure, whereas CuO exposure produced a more persistent rise in Aβ level. Together, the in vitro and in vivo experiments provide insights into PM component neurotoxicity and their contributions to AD-related neurodegeneration.

11WF.1

Impact of Wildfire Smoke on Indoor Air Quality in K-12 Schools in the Western US.
Jimmy Dimpor, Tristalee Mangin, Kerry Kelly, Ryan Thalman, NANCY DAHER, *University of Utah*

Wildfire activity in the western United States has increased substantially in recent decades, leading to more frequent and prolonged smoke episodes and increasing exposure among vulnerable populations. As this burden grows, wildfire smoke is becoming a major driver of indoor $PM_{2.5}$ in school buildings, yet the role of building characteristics and HVAC operation in modifying indoor exposure remains poorly characterized. To address this, indoor and outdoor $PM_{2.5}$ and CO_2 concentrations were measured using low-cost sensors at 15 K–12 schools in Utah. Across buildings equipped with MERV 8 filtration, outdoor-to-indoor smoke infiltration ratios were consistently higher during periods when HVAC systems were operating, with values reaching up to 0.85. Higher infiltration ratios were also associated with increased air exchange rates, indicating that ventilation can enhance the penetration of outdoor smoke in the absence of effective filtration. During a 2025 wildfire smoke event, 24-hr indoor $PM_{2.5}$ concentrations reached levels up to 55 $\mu g/m^3$ in some buildings. These findings highlight a critical tradeoff between ventilation and protection from outdoor pollutants and underscore the importance of HVAC operation strategies for reducing indoor smoke exposure in school environments.

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11WF.2

A New Method of Long Term Smoke Exposure for Mouse Model Studies, from Capture to Exposure. HOVANNESS DINGILIAN, Veronica Penuelas, Terese Garcia, Kainoa Koffman, Joule Parker, David Lo, Andre Obenaus, Thomas Eckel, David R. Cocker, *University of California, Riverside*

Wildfire smoke affects the pulmonary and neural health of those exposed to events such as the Pacific Palisades and Eaton Canyon fires in January 2025. When studying the health impacts of such events, methods such as quartz furnaces have been used, allowing for mice to be exposed to smoke, but only for a couple of hours. In this presentation, a new method of smoke exposure allowing mice to be exposed to smoke aerosol for 2 to 7 days without interruption will be presented. Biomass burns and military burn pits were chosen for these medical studies due to their known impact on health. Biomass burns were represented by pine needles while military burn pit burns consisted of JP8, tire, simulated medical waste, MREs, and Uniform. The materials were burned in the Pit Master 2.5, a 4 x 4 x 8 ft in house aluminum chamber. Emissions were captured and used to create a solution that was aerosolized into a chamber housing mice. Emissions from the aerosolized solution were directly compared to the emissions from the burns themselves to indicate similarities and differences between each other. Results show that the solution primarily mirrors the wildfire burn with less of a focus on gases such as Carbon Monoxide (CO) and Black Carbon. The solution puts more of a focus on Organic Carbon as well as inorganic ions and elements. Results from the mouse models indicate health impacts such as a difficulty in breathing due to more resistance in gas exchange. This new method allows for long term exposures for mouse models to smoke and develops a deeper understanding of how smoke affects human health.

11WF.3

Urinary Metabolites of Unsubstituted and Methylated PAHs Before, During, and After Wildfires. RUOXUE CHEN, Yan Lin, Xiangtian Wang, Chenyu Qiu, Wu Chen, Zhenchun Yang, Zhanghua Chen, Junfeng Zhang, *Duke University*

Background: Wildfire smoke is increasingly recognized as a major health concern, yet personal exposure remains poorly understood. Urinary hydroxylated PAHs (OH-PAHs) have been used in biomonitoring of general combustion-generated exposures, lacking specificity to specific combustion sources. Our previous campfire study demonstrated heightened specificity of urinary PAH-carboxylic acids (PAH-CAs, metabolites of methylated PAHs), to capture acute woodsmoke exposure than OH-PAHs. This work builds on those findings by testing their utility in capturing real-world wildfire exposures.

Method: Urine samples were collected during the early and late-fire stages (n=64) from 21 Los Angeles residents, matched to individual-specific pre-fire baselines. The samples were analyzed for OH- and CA- naphthalene (Nap), phenanthrene (Phen), and pyrene (Pyr) using LC-MS/MS.

Results: Using linear mixed-effect models to account for repeated measures and inter-individual variability, we found substantial increases in all measured PAH-CAs during the early-fire stage, with Nap-CA (+206.8%, 95% CI: 96.6%-378.9%), Phen-CA (+105.5%, 95% CI: 19.6%-253.1%), and Pyr-CA (+52.3%, 95% CI: 7.6%-115.5%). Meanwhile, 1-OH-Pyr and 1,9-OH-Phen also increased (+257%, 95% CI: 65%-669% and +73.3%, 95% CI: 17.3%-156.1%%, respectively). 1-OH-Nap showed no significant change. At the late-fire stage, 1-OHP and Pyr-CA levels returned to baseline, whereas Nap-CA and Phen-CA remained comparable to levels observed at the early fire stage. This aligns with the existing literature, which indicates that gaseous smoke constituents (e.g., methyl-Nap and methyl-Phen) can persist by adhering to indoor surfaces and re-emitted into the air.

Conclusion: Our findings provide the first real-world evidence supporting PAH-CAs as exposure biomarkers of wildfire smoke.

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11WF.4

Black Carbon as Urinary Biomarker of Acute Wood Smoke Exposure: Time Dependent Excretion Kinetics. XIANGTIAN WANG, Ruoxue Chen, Lisa Cameron, Yan Lin, Junfeng Zhang, *Duke University*

Black carbon (BC), a major component of combustion-derived particulate matter, is prevalent in traffic emissions, wildfire smoke, and tire-wear particles. Despite increasing concern over human exposure, biomarkers reflecting internal BC dose and clearance dynamics in humans remain poorly characterized. Urinary BC is a promising exposure biomarker, yet its measurement has been reported in few studies and its excretion kinetics following exposure has not been examined.

We optimized a multiphoton microscopy–based method for quantifying urinary black carbon. Refinement of sample preparation, image acquisition, and particle analysis workflows enabled reproducible detection and quantification of black carbon particles in both prepared standards and human urine samples using an upright imaging platform.

The method was applied to urine samples from a controlled wood-smoke exposure study (0–4 h exposure). Baseline unadjusted urinary BC concentrations had a median of 4.9×10^5 particles·mL^{-1} (range: 2.2×10^5–8.6×10^5); post-exposure concentrations reached a maximum of 2.4×10^6 particles·mL^{-1}. Time-dependent responses were evaluated using percent change from baseline in creatinine-adjusted urinary BC. For example, in participate, BC levels increased at 2-h post-exposure (123%, 89–318%), reached a peak at 4-h (523%, 467–690), declined at 6-h (127%, 83–171), and showed a second peak at 8-h (696%, 332–730), before declining toward or below baseline at later time points.

Urinary BC responds dynamically to acute wood-smoke exposure, highlighting the utility of change-based metrics for assessing short-term internal exposure. These findings support urinary black carbon as a sensitive biomarker of acute exposure and motivated us to further evaluate its utility in individuals exposed to wildfire and wildland-urban interface fire smoke.

11WF.5

How Smoke Plume Aging Conditions Influence Oxidant Generation in Simulated Lung Fluid. DAVID DE HAAN, Matthew Stephenson, Evelyn Yandle, *University of San Diego*

Recent epidemiological studies have suggested that smoke from biomass burning / wildfires is more hazardous to breathe than other types of PM2.5 particles. Smoke PM was 5x more likely to cause asthma hospitalizations, 8x more likely to cause ischemic heart disease, and 3x more likely to cause chronic obstructive pulmonary disease, compared to non-smoke PM2.5. These health hazards correlate with amounts of reactive oxidant species (peroxides, superoxide and hydroxide radicals) that are generated by the aerosol as they enter the epithelial lining fluid (ELF). We have conducted lab simulations of oxidant generation in simulated ELF by fresh and aged smoke particles generated by biomass burned under smoldering conditions in a 400C tube furnace. OH radical production was quantified using the fluorescent product of terephthalic acid, while total oxidants were quantified by terephthalic acid losses. Smoke aging on a timescale of hours was accomplished using ozone, OH radicals, and/or sunlight under wet and dry conditions in a small outdoor chamber. Our results indicate that ROS generation in ELF by smoldering smoke particles is highly sensitive to the oxidant used and the RH level during smoke aging. Aging smoke with ozone or OH radicals under dry conditions caused subsequent ROS generation in ELF to significantly increase.

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12AC.1

The Impact of the 2020 COVID-19 Pandemic on Aerosol Acidity. Kaitlyn G. Mahoney, Nicolina R. Sainthyle, Naomi A. Schluetter, ABIOLA S. LAWAL, *University of Connecticut*

Adoption of net-zero energy solutions for climate initiatives such as electric vehicles (EVs) is purported to lead to decreases in emissions, lower levels of ozone, fine particulate matter ($PM_{2.5}$), and improved air quality. What is not clear, however, is the impact of these reductions on aerosol acidity. Despite decadal emission reductions, aerosols have remained largely acidic. Understanding the potential impact of such adoption strategies on aerosol acidity is critical to evaluating climate-air quality mitigation strategies and impacts on human health. Findings from studies suggest that continued emission reductions of both NOx and sulfate (SO_4^{2-}) aerosol components could lead to changes in aerosol acidity. We explore this by evaluating aerosol acidity changes during the 2020 COVID-19 pandemic lockdown period, where substantial reductions in NOx were observed across several U.S. metropolitan cities. Here, total concentrations consisting of gaseous and aerosol components were obtained from the Clear Air Status and Trends Network (CASTNET) and the Ammonia Monitoring Network (AMoN) at collocated sites for February and March in 2019, 2020, and 2021. A CASTNET site in Georgia, situated ~40 miles from the Atlanta Metropolitan area was selected as the focus area. Relative humidity and temperature were collected from nearby air quality network (AQS) monitors. The collected data served as inputs to the aerosol thermodynamic equilibrium model, ISORROPIA, to determine aerosol pH. Findings showed that due to NOx reductions from the 2020 pandemic lockdown, relative sulfate proportions were higher in 2020 than before and after the pandemic period (36%, 38%, 36%), resulting in slightly lower average pH during that time in comparison (i.e., 2.44, 2.32, 2.98). With changes in pH attributed to NOx reductions and higher SO_4^{2-} ratios, the findings here suggest that initiatives such as widespread EV adoption without consideration to other sources will not have the full mitigating effect on aerosol acidity.

12AC.2

Influence of Surface Charge on Aerosol Physicochemical Properties, Aggregation, and Ice Nucleation. SARAH D. BROOKS, Roya Safa, Daniel Thornton, *Texas A&M University*

The role of surface charge is underappreciated in aerosol science. Chemical and physical changes in aerosols, including oxidation, aggregation and phase changes may be influenced by surface charge. To date, experimental measurements quantifying these influences are rare and need to be confirmed. For instance, surface charge may explain why certain chemical reactions can occur on water droplet surfaces that do not occur in bulk water. In addition, surface charge promote protein aggregation under certain conditions. Under the right conditions, stable aggregates form at zeta potentials more negative than -30 mV or more positive than +30 mV. Proteins with zeta potential between -30 and +30 mV are still charged, but don't form stable aggregates. Our own measurements of proteins (RuBisCO, thyroglobulin and cytochrome c) combined with mono and divalent cations found in seawater indicated that samples with high surface electrical potential tended to form uniformly large aggregates. In contrast, samples with lower potential featured fewer aggregates distributed across wider range of sizes. Finally, in our study of heterogenous ice nucleation, samples with high surface electrical potential were more effective at facilitating ice nucleation. Our observation suggest that surface potential influences and may even be a new and useful predictor of ice nucleation efficiency.

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12AC.3

Phase Transitions in Multicomponent Systems Relevant to Atmospheric New Particle Formation. Dilini Kirindigoda Gamage, MIRIAM FREEDMAN, *The Pennsylvania State University*

New particle formation and growth is responsible for approximately half of cloud condensation nuclei. Nucleating particles form from molecular clusters of sulfuric acid, water, ammonia, and/or amines, and grow through the condensation of highly oxidized organic molecules. The presence of multiple organic and inorganic components in these particles can lead to substantial variation in morphology and phase state, impacting their growth rate as well as their activity towards forming a cloud condensation nucleus. In this study, we have used optical and Raman microscopy to characterize the morphology and phase state of model droplets with composition relevant to new particle formation. In particular, we have focused on the systems of 2-methylglutaric acid, sulfuric acid, and ammonium sulfate with a range of amines; and dipropylamine, sulfuric acid, and ammonium sulfate with a range of dicarboxylic acids. Many systems are observed to undergo liquid-liquid phase separation, including several where the dicarboxylic acid/ammonium sulfate system does not, indicating an influence from the amine. The deliquescence relative humidity (DRH) is generally the same or lower than the dicarboxylic acid/ammonium sulfate system, and the efflorescence relative humidity (ERH) is generally similar. These results give insight into the morphology and phase state of particles that nucleate in the atmosphere, which is important for their heterogeneous chemistry and hygroscopicity.

12AC.4

Modeling and Parameterization of Size-Dependent Processes in Multiphase Aerosol Chemistry. Sandhya Sethuraman, Daniel Westervelt, Kedong Gong, Vicki Grassian, V. FAYE MCNEILL, *Columbia University*

Many atmospherically relevant multiphase reactive systems exhibit size-dependent kinetics in laboratory studies, with apparent reaction rates increasing with decreasing droplet size, suggesting an important role for interfacial processes. Here, we present CHAI (CHemistry of Aerosol Interfaces), a physicochemical modeling framework that describes these reactive systems using an additive resistance approach, considering the various mass transfer and reaction processes taking place simultaneously in the gas phase, droplet bulk, and at the droplet surface, and their relative timescales. We demonstrate its applicability to modeling and developing parameterizations for several inorganic and organic oxidation processes in microdroplets and aerosols, including S(IV) to S(VI) conversion, through simulation of experimental data. CHAI is also used to reconcile single-droplet observations with chamber and flow tube experiments and is extended to parameterization of these processes for representation in large-scale atmospheric models. Our results show that neglecting the size dependence of aerosol reaction processes can lead to inaccuracies in atmospheric chemistry modeling, motivating the CHAI approach for modeling these multiphase reactive systems and further experimental studies.

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12CA.1

Spatial Heterogeneity of Organic Aerosol Composition and Formation in Two Contrasting Neighborhoods in Greater Boston. ABIR SAHA, Khanh Do, Yang Zhang, Shang Liu, *Northeastern University*

Submicron organic aerosol (OA) exhibits substantial spatial heterogeneity at the urban scale, which is often not captured by sparsely distributed regulatory monitoring networks. To characterize these fine-scale structures, we conducted 120 h of mobile measurements across two demographically contrasting neighborhoods in Greater Boston: Chelsea, an environmental justice community, and Brookline, a more affluent area, over a three-month campaign in the summer of 2025. Spatial mapping revealed sharp intra-neighborhood gradients, with OA and black carbon (BC) concentrations in Chelsea significantly higher than those in Brookline (OA: 4.7 vs 3.6 μg m^{-3}; BC: 0.3 vs 0.2 μg m^{-3}). Sulfate was also higher in Chelsea than Brookline (0.5 vs 0.3 μg m^{-3}), whereas nitrate was similar between sites (0.09 vs 0.08 μg m^{-3}). High-resolution mobile transects identified persistent hotspots in Chelsea linked to heavy-duty traffic and industrial activity, whereas Brookline exhibited a more homogeneous distribution. Positive Matrix Factorization (PMF) was applied to the high-resolution time-of-flight aerosol mass spectrometer spectra to spatially resolve the OA sources. Primary OA was attributed to Hydrocarbon-like OA (HOA; 7% in Chelsea, 5% in Brookline) and cooking OA (COA; 11% in Chelsea, 15% in Brookline), with COA concentration peaking near restaurants. Secondary fractions dominated the total OA mass. Chelsea showed higher more-oxidized oxygenated OA (MO-OOA: 2.6 μg m^{-3}), while Brookline had a relatively larger less-oxidized fraction (LO-OOA). Van Krevelen analysis of the elemental ratios (H/C, O/C) suggests that the secondary fractions of OA are highly oxidized, and the mass spectra of the OOA factors suggest precursors from mixed biogenic and anthropogenic sources. These findings have important implications for explaining spatial heterogeneity in atmospheric chemistry and potentially urban exposure disparities.

12CA.2

On-Road Measurements and Characterization of Tire-Wear PM Emissions. ELIZABETH DEFRANCE, Zisimos Toumasatos, Georgios Karavalakis, *University of California, Riverside*

Non-exhaust emissions have gained increasing attention in recent years as combustion-generated (tailpipe) emissions from mobile sources continue to decline and concerns about air quality and public health grow. Current regulatory efforts are focused on reducing particulate non-exhaust emissions produced by brake and tire wear. Tire-wear particles are small particles abraded from tires during driving due to friction with the road surface and can contribute to ambient ultrafine particle emissions, as well as to PM2.5 and PM10 emissions. This study used a novel sampling system to assess tire-wear particle emissions from in-use vehicles under real-world conditions. Tire-wear testing was performed on six different tires from five different manufacturers over multiple routes representing urban and highway driving, as well as concrete and asphalt road surfaces. In addition to gravimetric PM2.5 and PM10 emissions, real-time particle number and particle size distributions were obtained under all driving conditions. Particle morphology and composition were performed by employing a scanning electron microscopy (SEM) with Energy Dispersive X-ray (EDX). Trace elements and metals were analyzed with an X-ray fluorescence (XRF) method. PM emission samples were also chemically characterized for organic rubber compounds, including N-(1,3-dimethylbutyl)-N'-phenyl-p-phenylenediamine (6PPD), 6PPD-quinone, diphenylquanidine,, 1,3-diphenylurea, 1H-benzotriazole, 2-minobenzothiazole, and many more.

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12CA.3

Standardization of Black Carbon Measurements in Europe.

Griša Močnik, Luka Drinovec, Thomas Müller, Eija Asmi, Ernest Weingartner, Krzysztof Ciupek, Konstantinos Eleftheriadis, KONSTANTINA VASILATOU, Jorge Saturno, *University of Nova Gorica*

Black carbon (BC) features the highest light-absorption per unit mass of all aerosols. It plays an extremely important role in the anthropogenic impact on the Earth's climate, albeit with a large uncertainty. This can be reduced only through measurements. Reporting BC emissions has been required under the Convention on Long-Range Transboundary Air Pollution since the 2012 revision of the Gothenburg Protocol, and BC monitoring will be mandatory in the European Union through the Directive on ambient air quality and cleaner air for Europe (2024/2881) starting in 2030. This requires standardization of the BC measurement.

We report results of our standardization efforts starting with reference methods (photo-thermal interferometry, PTI; extinction-minus-scattering, EMS) for the measurement of the aerosol absorption coefficient at multiple wavelengths traceably calibrated to primary units, with uncertainties around 5% and showing the differences between PTI and EMS, especially at high SSA; the determination of mass absorption cross-section for fresh and aged (coated) BC using elemental (EUSAAR2 protocol) and refractory carbon as mass metrics; and the use of these to calibrate filter photometers (multiple-scattering parameter C). We show results of laboratory and ambient measurements and approaches to characterize the aerosols and quantify the measured parameters with very small uncertainties.

We determined similar C values for the Aethalometer AE33 to recent ones using PTI as the reference. We found higher harmonization factors than those initially proposed by manufacturers assuming a constant C, and two-times higher than those reported previously from comparisons with the Multi-Angle Absorption Photometer (MAAP). Lower C values were observed for ambient-like test aerosols, containing fresh and aged soot, salt and dust particles, than for fresh soot. The MAAP showed much better agreement with PTI (typically within 50 %) than other tested filter photometers, indicating that the former can be used as a transfer standard once calibrated with PTI.

12CA.4

Restructuring of Black Carbon Aggregates Upon Coating with Commercial Fragrances and Their Products of Ozonolysis.

CHRISTIAN ESCRITT, Habeeb Al-Mashala, James Radney, Elijah Schnitzler, *Oklahoma State University*

Black carbon (BC) is a major urban component of fine particulate matter contributing to overall air quality, climate, and visibility. When initially emitted via incomplete combustion of fuel, the aggregates have branched, irregular morphologies. BC aggregates can then interact with other species in the atmosphere leading to compaction into more sphere-like morphologies, potentially increasing deposition in the lungs as well as altering the optical and hygroscopic properties of the BC, which impact its interactions with radiation and clouds. One category of species that BC can interact with is volatile chemical products (VCPs), which are becoming an increasingly large source of volatile organic compounds and organic aerosol in urban/indoor environments. This work focuses on the restructuring of size-selected BC caused by representative VCPs as well as the secondary organic aerosol (SOA) formed by the oxidation of VCPs via ozonolysis. To explore the effects of VCPs, we selected a homologous series of geranyl esters as coating materials in saturator-condenser experiments. An in-house custom-built electrostatic precipitator was deployed to quantify mobility diameters without evaporation of the volatile coatings, and the geranyl esters were found to be extremely efficient, by volume, at inducing BC restructuring. To explore the effects of SOA from VCPs, δ-cadinene, a sesquiterpene, was selected as a volatile organic compound and injected into a chamber with BC and then exposed to ozone. From series of diameter and mass growth factors for coated and coated-denuded BC particles, we determine that SOA from VCPs can have significant effects on the morphology of BC in the urban environment.

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12CM.1

Range Hood Use and Impacts on PM2.5 from Cooking: Results from a Field Study. Yi Fang, Haoran Zhao, Anabelle Garza, Arlette Garcia-Ramirez, Briseida Vasquez, Debra Garcia, Jesus Rivera, Tim Tyner, Stephanie Holm, John Balmes, BRETT SINGER, *Lawrence Berkeley National Laboratory*

The Cooking Energy and Ventilation Impacts on Children's Asthma (CEVICA) study measured indoor air quality of switching from gas to electric induction cooking in California's San Joaquin Valley. The study also evaluated the effectiveness of venting range hoods as a control on cooking-related pollutants. Particle concentrations were measured during 2-week intensive periods before and approximately three months after the intervention, which was randomized in two stages. Filters sampling quantified gravimetric $PM_{2.5}$ and time-resolved $PM_{2.5}$ were measured by two different IAQ monitors with low-cost sensors. Indoor-emitted $PM_{2.5}$ events were identified from rapid increases from local baseline concentrations. Cooking activities were identified using temperature sensors installed above cooktops, and range hood (RH) operation was identified using anemometers, smart plugs, or motor loggers. Across 115 intensives in the first 39 homes, 4,184 cooking events and 1,038 RH use events were identified. RH use occurred more frequently during longer cooking events and those with detectable $PM_{2.5}$ increases, suggesting preferential use during higher-emission cooking. By intensive, total integrated $PM_{2.5}$ during cooking tended to be lower with increased hood use, but not statistically discernible. Gravimetric $PM_{2.5}$ decreased with greater RH use during both gas and induction cooking phases with marginal confidence of $p=0.2$ for gas and $p=0.06$ for induction. Analysis of data from another 60 study homes are ongoing. These findings suggest that RH operation may reduce time-integrated indoor $PM_{2.5}$ exposures during residential cooking, while also demonstrating that interpretation of event-level cooking $PM_{2.5}$ concentrations can be influenced by behavioral patterns in RH use.

12CM.2

Optimization of Airflow at High Containment Large Animal Facilities to Reduce Pathogen Spread. Juan Garcia Lunar, John Cate, Julia Bippus, Eduardo Escamilla Rodriguez, Stephen King, Kurt Zuelke, MARIA KING, *Texas A&M University*

Heating, ventilation and air conditioning (HVAC) systems in high containment facilities not only provide a means of transport for bacteria and viruses but may also trigger increased dispersion, concentration, and infectivity of bioaerosols by mechanisms unknown. This study aims to fill this gap by determining the aerosol dispersion patterns of surrogate pathogens in two holding pens and a necropsy room within an ABSL-3Ag large animal research facility and investigating how varying air changes per hour (ACH) rates or room configuration impact potential biosafety risks. We employed computational fluid dynamics (CFD) airflow modeling using ANSYS Fluent with Eulerian flow solvers, Reynolds-averaged Navier-Stokes equations and air property measurements with bioaerosol collection and molecular analysis to determine the movement of bioaerosols in the room airflow at 0 and 15 ACH. Mid-log phase bacterial pathogen surrogates were disseminated in the center and collected at eight locations in each room using the wetted wall cyclone bioaerosol collectors. Compared to 0 ACH, total cell counts of collected aerosols were a magnitude higher while culturable counts decreased by two magnitudes at 15 ACH in all rooms. CFD modeling shows turbulent air vortices in all rooms at 15 ACH. The holding rooms, with a ventilation configuration placing central exhaust openings with peripheral wall intakes show more symmetrically distributed streamlines and aerosol concentrations, albeit with higher pathogen numbers at the sides that are transported farther towards the walls at 15 ACH. However, in the necropsy room with the intake row above the entrance and exhaust openings in the side wall at floor level, high cell concentrations are maintained around the bioaerosol source in the center even at 15 ACH.

This study underlines the importance of identifying room layout and HVAC configuration factors affecting airflow patterns to design optimized ventilation systems, prevent pathogen entrainment and mitigate biorisks in critical facilities.

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12CM.3

Performance Evaluation of a Hybrid Ambient Air Purification Device in an Open and Semi-Enclosed Urban Microenvironments: Field Measurements and CFD Analysis. PRASHANT NAWALE, Manoranjan Sahu, *Indian Institute of Technology Bombay*

Urban particulate matter hotspots, mainly construction zones and high-occupancy institutional areas, exhibit elevated exposure risks due to limited dispersion and continuous emissions. Localised ambient air purification has been proposed as a mitigation strategy; however, its effectiveness under varying enclosure conditions remains insufficiently quantified. This study investigates the performance of a hybrid ambient air purification device (APD) integrating ionisation and multi-stage filtration across two representative urban microenvironments: (i) an open campus space and (ii) a semi-enclosed, active construction site adjacent to a school. The dual-site design isolates the role of geometric confinement and background turbulence in governing pollutant removal. The APD, designed at 9600m^3/h, was evaluated over a 45m × 45m study domain using a reference-grade aerosol spectrometer under controlled on/off operations. Results indicate a statistically significant reduction in PM_{10} of 82±8.1% (51.8 µg/m^3) at the outlet and 20.8±4.2% (12.6 µg/m^3) 50m upwind, relative to background levels, during 48-hour monitoring. Performance was site-dependent: the semi-enclosed construction environment exhibited consistently higher reductions (71-92%) compared to the open site (54-81%) for PM_{10}, attributable to reduced advective losses. $PM_{2.5}$ reductions were comparatively lower, reflecting limits on filtration and ionisation efficiency at higher flow velocities. Complementary CFD simulations reproduced observed spatial trends. They estimated an effective cleaning zone corresponding to a 10% concentration reduction up to 50m downwind, demonstrating strong sensitivity to ambient wind speed and enclosure geometry. Additionally, open site experiments confirmed that removal efficiency decreases with increasing device throughput due to high inertia, reduced particle capture time, and decays nonlinearly with distance from the APD. Overall, the results demonstrate that hybrid APDs are more effective in semi-confined environments where flow recirculation enhances pollutant capture. The findings provide quantitative design and deployment insights, emphasising the importance of site morphology, operating conditions, and scaling considerations for urban air quality interventions.

12CM.4

Aerosol Reduction and Visibility Improvement with a Novel Dental Handpiece. Pan-Chin Kung, Hsin-Hung Chien, Yung-Chung Chen, Chun-Juei Chou, MING-YENG LIN, *National Cheng Kung University*

Dental handpieces are commonly used in dental clinics to polish and shape teeth. When using dental handpieces, the water jet is continuously sprayed onto the dental burr for cooling purposes. This process generates a high concentration of aerosol and water mist, which can spray onto patients' faces, causing discomfort. Furthermore, this can also result in transmission of airborne diseases in dental clinics. Local exhaust ventilation is sometimes used in dental clinics to improve air quality, but it is bulky and cannot confine the aerosol and water mist. In this study, we developed a compact dental handpiece with a modified cooling method and an improved air curtain to help confine the aerosol. We aim to see the efficiency of the novel dental handpiece in reducing viral aerosol dispersion, improving visibility, and cooling proficiency. We used MS2 bacteriophage as a non-pathogenic surrogate for viral aerosol. A six-stage Andersen impactor and passive air sampling technique (settle plates) were placed around the dental handpiece to investigate viral aerosol dispersion. Different cooling methods (water jet, air jet), air curtain flow rates (5 LPM, 10 LPM, and 20 LPM) were tested. We also used a Scanning Mobility Particle Sizer (SMPS; DMA Model 3081 and CPC Model 3010, TSI Inc., MN, USA) to monitor aerosol concentration near the source. To analyze the improvement in visibility, we used the Peak Signal-to-Noise Ratio (PSNR) and the Structural Similarity Index Measure (SSIM). A thermal Imaging Camera (model FLIR E5, Teledyne FLIR, OR, USA) is used to monitor the temperature at the dental burr. Preliminary results indicate that the novel dental handpiece can reduce aerosol dispersion, improve visibility, and assist cooling. This improved dental handpiece can not only reduce aerosol exposure in dental offices but also make future dental visits more pleasant.

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12HR.1

Ultrafine Particles in Roadway and Near-Roadway Environments in Senegal. SUZANNE E. PAULSON, Kyle Caulson, Jiaqi Shen, Baidy Sow, Bertrand Tchanche, Shallon Kobusinge, *University of California, Los Angeles*

West African roadways carry many very old and poorly maintained vehicles, many of which are diesels, mixed with newer vehicles. No previous measurements of ultrafine particles in such environments have been reported. In March, April and November of 2024, using fast response instruments, we made mobile measurements of particle number, average ultrafine particle size, and PM2.5 mass and black and brown carbon concentrations, on all roadway types in Northern Senegal and rural parts of The Gambia. Data were collected on controlled access highways, arterials, collectors and local streets, in both urban and rural environments. Additional measurements were made in several near-roadway environments. While background concentrations of ultrafine particles were slightly elevated relative to similar environments in cities in the West, on-road ultrafine particle concentrations were extraordinarily elevated, commonly averaging above 5×10^5 - 1×10^6 particles/cm3 and regularly peaking above 70 × 106 particles/cm3. Fine particle mass concentrations were elevated, but to a lesser degree, averaging 50 – 150 μg/m^3. Near-roadway decay profiles of ultrafine particle concentrations were similar to those observed in many earlier studies, with concentrations decaying by 90% or more within 100 – 300 m. The wavelength dependence of particle light absorption indicates the particles are overwhelmingly from transportation-related fossil fuel combustion. Using a random forest analysis of about 100,000 measurements, we find that the highest ultrafine particle concentrations are associated high-speed traffic, even at low traffic densities. Other factors that result in high concentrations at lower vehicle speeds are earlier times of day and higher population density and more urbanization, proxies for high traffic levels. In many locations, large numbers of people spend many hours each day immediately adjacent to the roadways, so that these very high roadway emissions impact large numbers of people beyond roadway users.

12HR.2

Beyond PM2.5: Localized Sub-10 nm Ultrafine Particle Bursts from Natural Gas Combined Heat and Power Facilities in an Urban Environment. Stephanie Bachman, Jonah Hazelwood, Lintong Cai, Markus Petters, NICHOLAS MESKHIDZE, *North Carolina State University*

Urban air quality monitoring increasingly reveals ultrafine particles (UFP) below 10 nm, yet their emission sources and atmospheric evolution remain poorly characterized. This study investigates extraordinary sub-10 nm particle events observed during rooftop aerosol measurements in Raleigh, NC, where particle number concentrations (PNC) reached up to 3×10^5 cm^{-3}. The combination of sub-10 nm modal diameters persisting stably for multiple days pointed to local primary emission sources rather than regional new particle formation (NPF).

To identify and quantify contributing sources, we employed a multi-method approach combining continuous aerosol measurements, source inventory analysis, and atmospheric dispersion modeling. Campus surveys and satellite imagery identified three candidate sources within the measurement domain, notably two combined heat and power (CHP) facilities equipped with high-efficiency natural gas turbines and heat recovery steam generators serving NC State University. The EPA's AERMOD Gaussian plume model was applied to simulate particle transport from each facility to the receptor site across diverse meteorological conditions, using an emission factor of 5×10^{-4} g s^{-1} and incorporating sensitivity analyses for wind speed, wind direction, solar radiation, and planetary boundary layer height. Wind pattern analysis successfully resolved individual plume contributions from separate facilities, and statistical analyses identified wind direction and speed as primary predictors of modeled mass concentrations, clearly differentiating plume episodes from NPF events.

A particularly striking finding emerged from growth rate analyses during plume transport. Leveraging periods of stable wind direction with variable wind speeds, we calculated sub-10 nm particle growth rates averaging > 100 nm hr^{-1} – substantially exceeding previously reported values. These results highlight critical gaps in air quality regulations that prioritize particle mass (PM2.5, PM10) over number concentrations in the ultrafine range, and suggest that widespread adoption of natural gas CHP systems for distributed urban energy generation may introduce underappreciated health risks through localized UFP emissions.

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12HR.3

Estimating Health Risks of Urban Air Pollution in Karachi Using Cigarette-Equivalence Metrics. HAIDER KHWAJA, Najm Madani, David Carpenter, *University at Albany*

Air pollution remains a critical environmental health challenge, particularly in rapidly urbanizing regions of South Asia where exposure levels are high and systematically under-characterized. This study aimed to quantify the health risks associated with ambient air pollution in megacity Karachi, Pakistan, by applying the cigarette-equivalence approach developed by Van der Zee et al. Seasonal monitoring of fine particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2), and black carbon (BC) was conducted across multiple fixed-site locations representing diverse urban microenvironments. Health risks were assessed using four endpoints: low birth weight (LBW; <2500 g at term ≥37 weeks gestation), decreased lung function (measured as forced expiratory volume in 1 second, FEV_1), cardiovascular mortality, and lung cancer incidence. Pollutant-specific risk estimates revealed consistently elevated impacts, with $PM_{2.5}$ contributing to the highest relative risks across all endpoints. Average risk estimates for LBW, decreased lung function, cardiovascular mortality, and lung cancer were 37.2, 93.9, 51.9, and 31.3 ($PM_{2.5}$), 14.8, 38.8, 14.3, and 6.47 (NO_2), and 1.01, 2.87, 2.79, and 1.32 (BC), respectively. These findings highlight the substantial public health burden attributable to air pollution in Karachi, driven primarily by elevated $PM_{2.5}$ concentrations. The cigarette-equivalence framework provides an intuitive and policy-relevant method for communicating risks. The magnitude of observed effects suggests that residents may face broader and more severe health consequences than those traditionally associated with air pollution exposure. Urgent mitigation strategies and strengthened air quality management policies are warranted to reduce exposure and protect vulnerable populations in megacities across South Asia.

12HR.4

Personalized Source Apportionment for Community Applications. SUMUKHI PRASAD, Cesunica Ivey, *University of California, Berkeley*

Personal exposure studies oftentimes use wearable monitoring, but time-activity diaries are used to characterize the microenvironment. In cases where GPS data are collected with air pollution measurements, instead of time-activity diaries, source identification methods are limited due to the lack of pollutant speciation. In this work, we conduct mobility-driven source apportionment that leverages time-resolved CO2, PM2.5 and PM2.5 speciation from a wearable air pollution monitor (UPAS, Access Sensor Technologies). Our case study focuses on Martinez, California, a frontline refinery community in the greater Bay Area of Northern California, and presently there are no air pollution exposure studies for Martinez. A 2022 spent catalyst release prompted community organizing around air, water, and soil pollution mitigation, and our team has partnered with Healthy Martinez for ongoing environmental monitoring. Here, a chemical mass balance approach is used to determine source impacts at the individual scale, while taking into account time-activity patterns and microenvironment changes. This integrated and novel approach provides space-time estimates of exposures to PM2.5 sources over seven consecutive days for community participants. Findings will inform personalized exposure mitigation strategies for impacted community members and can be used to address inequities in exposure.

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12NP.1

The Kinetics of Aerosol 1D Fractal Aerosol Self-Assembly.

ADAM BOIES, Nabil Abomailek, Juan Vilatela, *Stanford University*

This research explores gas-phase dynamics and self-assembly mechanisms of high-aspect-ratio primary particles. Aerosol-based synthesis gelation is highly attractive because it allows for the continuous, single-step production of nanoscopic components into hierarchical, mesoscale 3D architectures known as aerogels. Because the macroscale properties of these materials, e.g. stress, phonon, and electron transport, are governed by their inter-particle organization, understanding their kinetics of assembly is critical for property optimization.

The presentation discusses multiscale modeling efforts that simulates high-aspect-ratio 1D nanoparticles across disparate time and length scales.[1] This includes atomistic molecular dynamics for parameter validation, an adaptive mesoscale "bead-spring" model that discretizes nanorods and nanotubes into nodes to simulate lengths exceeding 10 µm, and a novel physics-based semi-analytical model.[2] Recent findings show that semi-analytical approximations of nanorods as rotating rigid cylinders achieve results within 10% accuracy of mesoscale simulations at less than 0.1% of the computational cost, thereby enabling the study of ultralong nanotubes and large bundles common in industrial processes.[3]

A key finding is the identification of two distinct reorientation regimes following nanotube collision: an initial "central rotation" phase and a subsequent "zipping" motion. The reorientation time is strongly dependent on CNT length, following a power law, and is highly sensitive to the initial collision angle and linear density. Furthermore, the inclusion of gas-phase drag is shown to lengthen reorientation times by up to two orders of magnitude, a factor often ignored in previous simulations. Notably, the torque due to van der Waals forces increases in discrete steps as bundle size grows, which can, counterintuitively, lead to faster reorientation in small bundles than in individual tubes.

New work, not yet published, explores the transition from a dilute aerosol to a macroscopic gel, which is analyzed through the "Ideal Gelation Point" (IGP), where the effective volume of clusters reaches the system volume, and they begin to interdigitate. Experimental and theoretical results indicate that as these systems become more concentrated, they evolve from low-dimensionality fractal agglomerates (fractal dimension $D_f \approx 1.7$) into dense superagglomerates and eventually volume-spanning gels ($D_f \approx 2.5$). This work provides a comprehensive theoretical framework for controlling the self-assembly of 1D nanoparticles, offering insights essential for engineering advanced nanomaterials with tailored bulk functionalities.

[1] Boies, et al., Small. 15, 1–10 (2019).
[2] Kateris, et al., J. Phys. Chem. C. 124, 8359–8370 (2020).
[3] Qiao, et al., Langmuir. 40, 21460–21475 (2024).

12NP.2

Aerosol-Phase Engineering of Heterogeneous Metal Nanoreactors.

CYPRIEN JOURDAIN, Adam Boies, *Stanford University*

Metal fractal nanoarchitectures are emerging as powerful reactors for catalysis, energy conversion, biosensing, and photothermal applications because of their exceptional radiative properties, high surface-area-to-volume ratios, and morphology-dependent plasmonic behavior. Although wet-chemical synthesis has enabled the fabrication of plasmonic porous nanocages, core-shell, and multifunctional nanostructures, scalable production remains limited by ligands, multistep processing, and restricted control of heterogeneous architectures. Gas-phase synthesis offers a continuous, ligand-free alternative capable of producing complex nanomaterials with tunable composition, morphology, and optical response. To date, there has been no evidence of porous nanocages with embedded cores produced via an aerosol route, which motivates this work.

We present a continuous method for engineering complex metal nanostructures with controlled physical and radiative properties. Bare aggregates (e.g., Al, Mg, W) were synthesized using evaporation–condensation and laser ablation techniques, spanning structures from sub-10 nm particles to fractal aggregates several hundred nanometers in diameter. Simultaneously, cores with near-spherical shapes were produced (e.g., polystyrene latex, acid stearic, metals). Aggregate compactness and gyration diameter were governed by agglomeration kinetics and surface energy, while additional restructuring was induced through capillary forces. The main mechanisms used are (i) aggregate-core attachment and (ii) aggregate compaction, i.e., cage formation. Electrostatic interaction between oppositely charged aggregates and cores enhanced physical attachment, while condensation and evaporation of a liquid phase promoted subsequent aggregates compaction. Following independent validation of these mechanisms, preliminary formation of porous nanocage-core structures was achieved. Particle size, mass, and effective density were continuously characterized using aerosol instrumentation. The optical performance of the resulting structures was estimated through joint optical simulations using a discrete dipole approximation model.

These findings establish aerosol-phase synthesis as a platform for the hierarchical assembly and functionalization of advanced metal nanoarchitectures with tailored structural and optical properties.

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12NP.3

Aerosol Metal-Organic Framework (MOF) Synthesis. ALMOND LAU, Ji Feng, Igor Novosselov, *University of Washington*

Metal-organic Frameworks (MOFs) are very promising materials for gas sensing, catalysis, energy storage, water purification and drug delivery due to their high porosity, tunable pore sizes, adequate chemical and thermal stability, and various structures and compositions. Downsizing MOFs to the nanoscale brings superior properties over their bulk analogs, such as high surface-to-volume ratio, rich exposed metals and ligands, short diffusion path for reactants, which all contribute to improved performances. While great efforts have been made to reduce the particle sizes by controlling the reaction kinetics or terminating the particle growth with additives, large-scale synthesis of MOF nanoparticles with simple methods remains a challenge. We report the supercritical CO_2 ($scCO_2$) assisted continuous-flow synthesis of MOF nanoparticles.

Operating in a single-phase ethanol-$scCO_2$ mixture, the method yields pure and thermal stable HKUST-1 nanoparticles with median sizes of 98-212 nm and BET surface area of 1613-1887 m^2/g in residence time of ~3 s without any additives. A typical dry yield of 53.7 wt% is achieved with 0.1 M copper precursor at 75 °C and 13 MPa. Size analysis of the products obtained at different copper concentrations shows the influence of supersaturation and fluid phase behavior to the nanoparticle formation. Fractal dimension analysis indicates that the growth is caused by aggregation of primary nanocrystals, indicating a non-classical crystal growth mechanism. The two growth pathways are (1) particle-particle assembly, where particles aggregate forming “Tetris-like” compact structures; and (2) vapor deposition, where ions and amorphous oligomers self-assemble in the nascent aggregates, filling up the hollow structures in the aggregates.

Zr-MOFs are highly stable and structurally versatile porous structures with catalytic metal sites. Defective UiO-66 is well-studied for this application in chemical adsorption; however, the challenge remains in their large-scale production. In contrast to HKUST-1, which forms rapidly through direct coordination between metal ions and organic linkers, the formation of Zr-MOFs involves a more complex process with slower kinetics, beginning with the assembly of Zr_6 metal-oxo clusters that are subsequently coordinated with organic linkers. This slow reaction makes it difficult to obtain high-quality crystals under reduced residence times, as decreasing residence time often leads to poor crystalline Zr-MOFs with reduced surface area and compromised performance in target applications.

We synthesized high-quality UiO-66, UiO-66-NH_2 and MOF-808 with ~1.2 min residence time. The role of $scCO_2$ is understood to promote the condensation of Zr-oxo clusters for fast nucleation, and the role of AA is to control the particle morphology from aggregates to single crystals.

12NP.4

Gelation of Graphene During Chamber Explosion Synthesis. Shusil Sigdel, CHRISTOPHER M. SORENSEN, *Hydrograph Clean Power, Inc.*

Chamber explosion synthesis is now an industrial scale method to create high-quality, multi-layer graphene with a fractal morphology from oxygen/acetylene precursor mixtures [1]. Here we present results for a wide variety of hydrocarbon precursors with a variety of oxygen/carbon ratios and, in some cases, inert “background” gases. All the O/C ratios were sub-stoichiometric such that elemental carbon was formed. We find precursor-dependent regimes of amorphous carbon black, powdered fractal multi-layer graphene, and graphene aerosol gels. Carbon black forms when the maximum temperature in the chamber during the explosion is less than 2100K. Above 2100K, powdered fractal graphene forms when the carbon volume fraction is small and the monomers of the fractals are large. Graphene aerosol gels form when the carbon volume fraction is large and the monomers are small. We show that these “large” and “small” adjectives are quantified by gelation theory our group presented ~ 20 years ago [2].

[1] “Chamber explosion synthesis of fractal aggregate graphene”, C. M. Sorensen*, S. Sigdel, C. Bartlam. S. H. Bossmann, K. Breure, S. Corkill, R. Divigalpitiya, A. Ejas, T. Eldridge, R. Estes, S. Li, A. Shakil; Graphene and 2D Materials https://doi.org/10.1007/s41127-025-00097-x (2025).
[2] “Aerosol Gelation: Synthesis of a Novel, Lightweight, High Specific Surface Area Material,” R. Dhaubhadel, G. S. Gerving, A. Chakrabarti and C.M. Sorensen*, Aerosol Sci. Tech. 41, 804-810 (2007).

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12WF.1

Sulfuric Acid Can Drastically Enhance the Absorption Properties of Wildfire Smoke Particles in the Stratosphere.

MEI FEI ZENG, Changda Wu, Zhaomin Yang, Erik Jackson, Sergey Nizkorodov, Allan K. Bertram, *University of British Columbia*

Severe wildfires can create pyrocumulonimbus clouds that rapidly transport smoke into the stratosphere. Examples include the 2019-2020 Australian Black Summer fires and the 2017 western North American fires. This smoke consists of large amounts of organic aerosol termed biomass burning organic aerosol (BBOA). Once lofted into the stratosphere, BBOA can mix with sulfuric acid (H_2SO_4), producing acid-aged BBOA whose optical properties remain poorly constrained. In this study, we estimated the mass absorption coefficients (MACs) of acid-aged BBOA by mixing BBOA water extracts with 10 and 16 M H_2SO_4, representative of stratospheric acid concentrations. Using ultraviolet-visible spectrophotometry, we investigated the changes in MACs of unaged BBOA and acid-aged BBOA. After 1 day of aging, the MACs of the acid-aged BBOA extracts drastically enhanced, consistent with light-absorbing brown carbon produced from acid-driven reactions. Using the measured MACs, we demonstrate that acid-aged BBOA particles can absorb a significant amount of solar energy in the stratosphere, potentially contributing to stratospheric heating. These results indicate that acid aging in the stratosphere can significantly enhance the MACs of BBOA and should be considered in assessments of wildfire environmental impacts.

12WF.2

The Interconnection of Bleaching, Phase State, and Volatility of Brown Carbon During Atmospheric Aging.

Jiayun Zhao, Mingsheng Fang, Ajith Thenoor Chandran, Guoyang Lei, Shunyu Yao, Burke Leonce, Raghu Betha, Garrett McKay, YUE ZHANG, *Texas A&M University*

Atmospheric brown carbon (BrC), often originated from biomass burning, contributes substantially to short-wavelength light absorption, despite large uncertainties of its chemical and optical evolution during atmospheric aging. Here we combine a vaporization inlet for aerosols with a Vocus chemical ionization mass spectrometer (VIA-Vocus) and a multiwavelength aethalometer to quantify the molecular composition, volatility distributions, and light absorption of BrC during O3 and •OH oxidative aging. Biomass-burning organic aerosol (BBOA) generated from the smoldering of Spanish Moss was extracted, re-aerosolized, and aged in a potential aerosol mass oxidation flow reactor (PAM) under O3-only and combined O3+•OH conditions at controlled relative humidity (RH). VIA thermograms were calibrated to derive effective saturation concentration (C∗) using polyethylene glycol standards, enabling compound-resolved volatility characterization. Fresh BBOA mass spectra were dominated by non-chromophoric tracers, particularly levoglucosan, whereas BrC candidates identified using double-bond equivalence to carbon number ratio (DBE/nC) criteria were minor in abundance but preferentially associated with lower volatilities. Oxidative aging induced pronounced chemical and optical changes. While O3-driven bleaching leads to a 61% drop in the mass absorption coefficient (MAC) and an increase in 4-fold increase of effective saturation concentration (C*), •OH-oxidation brings negligible or much slower optical modification but faster decreases the volatility and thus viscosity or BBOA. Our in-situ volatility-resolved results suggest that O3 and •OH play distinct roles in BBOA aging: O3 more effectively drives rapid BrC bleaching, whereas •OH more strongly shifts volatility and increases particle viscosity by several orders of magnitudes. These findings show that oxidants influence the evolution of BBOA phase state and optical properties during atmospheric aging jointly in future model simulations.

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12WF.3

Chromophores, Molecular Composition, Physical Properties, and Photolytic Aging of Wildland Urban Interface Burning Organic Aerosol. MATT ZARAGOZA, Luis Ruiz Armenta, Qiaorong Xie, Abigail Smith, Alexander Laskin, Kevin Ridgway, Christian L'Orange, Shantanu Jathar, Zoë Golay, Evan Chartrand, Allan K. Bertram, Zezhen Cheng, Gregory W. Vandergrift, Swarup China, Sergey Nizkorodov, *University of California, Irvine*

Fires at the intersection of vegetation and urban development generate wildland urban interface (WUI) burning organic aerosol (BOA) and are becoming more prominent worldwide. The chromophores and physical properties of WUI BOA are important for understanding visibility, climate radiative forcing, and heterogeneous chemistry in the atmosphere. The chemical composition of WUI BOA provides insight into potentially hazardous chemical constituents directly affecting first-responders and people residing in fire-prone areas. These characteristics of WUI BOA evolve in the atmosphere in response to UV radiation. Wood-based and plastic-derived structural materials were burned to generate WUI BOA, which was then exposed to UV radiation for simulated atmospheric aging by sunlight. UV-VIS spectroscopy tracked changes in the mass absorption coefficient (MAC) and UHPLC-PDA-HRMS analysis tracked individual chromophores and molecular composition in response to UV aging. The effect of UV exposure on the MAC depended on the material burned, resulting in either photobleaching or photoenhancement. Methoxyphenols were the most prominent chromophores and their abundances decreased with UV aging. Wood-based BOA contained unique species that may serve as tracers such as polypropylene glycols and organic acid plasticizers. Plastic-based BOA contained chalcones, phthalates, terephthalates, benzoic acid derivatives, and nylon-derived compounds. Poke-flow measurements constrained WUI BOA viscosities. The volatilities and predicted viscosities based on molecular compositions from TPD-DART-HRMS and nano-DESI-HRMS analysis showed stark differences between wood-based and plastic-based WUI BOA. Optical microscopy as well as flat and 60 degree tilted SEM imaging provided additional insight into the physical structure and physical properties of WUI BOA. Unique non-spherical morphologies were exhibited by the WUI BOA and photolysis significantly decreased WUI BOA particle volume.

12WF.4

RADSENSE: A Machine Learning-Based Smoke Forecast System. ZONGRUN LI, Eric Wendt, Shantanu Jathar, Jesse Burkhardt, Ander Wilson, Christian L'Orange, John Volckens, *Colorado State University*

Wildland fires have increased substantially in recent decades and have become a major source of $PM_{2.5}$ pollution in the United States. Smoke from these fires can travel long distances, affecting large populations downwind and causing severe respiratory and cardiovascular health impacts. Accurate and timely smoke forecasts are therefore critical for public health protection and emergency response. However, current operational smoke forecasting systems rely primarily on physics-based numerical models, which have uncertainties in plume height, emission time profiles, and emission intensity, leading to inaccurate near-surface smoke concentration predictions and limiting their usefulness for real-time decision-making.

In this study, we develop a machine learning (ML) based ensemble framework to improve operational smoke forecasts by correcting biases in the Unified Forecast System-Air Quality Model (UFS-AQM), a chemical transport model forecasting system operated by the National Oceanic and Atmospheric Administration (NOAA). Our ML framework integrates multiple data sources, including satellite-derived aerosol optical depth, meteorological forecasts, regulatory air quality monitoring data, and low-cost sensor observations, to bias-correct UFS-AQM forecasts. Three ML models, XGBoost, LightGBM, and CatBoost, are trained using an out-of-fold learning strategy and combined using optimized ensemble weights to generate improved hourly $PM_{2.5}$ forecasts up to 24 hours in advance. We evaluated the ML model's performance by comparing it with UFS-AQM. The ML ensemble framework substantially improved forecast accuracy, with R^2 values ranging from 0.76 to 0.42 across lead times from 1 to 24 hours, compared with R^2 values below 0.16 for the UFS-AQM forecasts. The ML model performance generally decreased as lead time increased, while the UFS-AQM forecasts showed consistently poor performance, particularly during nighttime. The ML model also produced more accurate air quality index (AQI) predictions than UFS-AQM, although both models produced false negatives for hazardous air quality days. We also conducted SHAP analysis to improve model interpretability, which showed that historical observations played an important role at short lead times, whereas UFS-AQM forecasts became more important at longer lead times. In addition to improved performance, the ML framework remained computationally efficient, reproduced the spatiotemporal patterns of $PM_{2.5}$, and provided probabilistic estimates of prediction uncertainty. This approach can be operationalized into same-day forecasting systems, with the potential to provide timely and reliable smoke alerts to the federal and state air quality agencies, public health organizations, and vulnerable populations.

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