Plenary I: Friedlander Lecture

Particle-Resolved Modeling: A Bridge between Scales in Aerosol Science. NICOLE RIEMER, *University of Illinois at Urbana-Champaign*

Atmospheric aerosols are mixtures of different chemical species, and individual particles exist in many different shapes and morphologies. This “aerosol state” continuously evolves in the atmosphere. Thanks to advances in measurement techniques, we have made great progress in our process-level understanding of the atmospheric aerosol. Why is it then that aerosols and aerosol-cloud interactions are still associated with the largest uncertainties in global climate predictions? A key reason for this is the inherent multiscale nature of the problem—processes on the micro-scale determine macro-scale impacts—and the challenges that this poses for our modeling efforts. In this presentation I will show how high-detail particle-resolved modeling fills an important gap in the hierarchy of aerosol models. The particle-resolved approach represents the atmospheric aerosol using individual computational particles that evolve in size and composition as they undergo transformation processes in the atmosphere. While computationally expensive, this approach is therefore not limited by assumptions about particle composition within a given size range. As a result, it can represent the evolution of the full aerosol mixing state without simplifying assumptions. My presentation will illustrate how particle-resolved modeling can provide insights into the spatio-temporal evolution of aerosol mixing state, going beyond the traditional definitions of “externally” or “internally” mixed populations. I will show how simplifying the diversity of aerosol composition introduces errors in our estimates of climate-relevant properties, such as cloud condensation nuclei concentration and aerosol optical properties. I’ll conclude the presentation by summarizing the measurement challenges that we face in constraining particle-resolved models, but which provide a unique opportunity in “getting the right answer for the right reasons”.

Plenary II: AEESP Lecture

Anti-racist Air-quality Modeling. JULIAN MARSHALL, *University of Washington*

Ambient air quality in the US has improved over time, thanks to steps such as the 1970 Clean Air Act. However, in part because of where pollution sources are located, people of color in the US are still, on average, more exposed to air pollution than are white Americans. Today, society’s goals for air quality include not only improving conditions overall, but also addressing systemic disparities. Models and measurements are needed to focus attention on how to achieve that goal; research is needed to help propose and test possible solutions.

This talk will discuss existing exposure-disparities and the need to evaluate strategies to eliminate them. Three aspects will be emphasized:

(1) *We don’t all breathe the same air.*
Today, the largest exposure disparities are by race-ethnicity. Disparities by race are larger than, and statistically distinct from, those by income. Exposure disparities reflect segregation of people and of pollution, which in turn reflect norms, laws, enforcement, acts of violence, and threats of violence, which have reenforced segregation. Over time, polluting land uses were more likely to locate in communities that lacked political power to object.

(2) *The past is present.*
Contemporary disparities reflect recent actions but also actions many decades ago. Race-based planning implicitly and explicitly included race in deciding where to locate polluting land-uses.

(3) *The disparities won’t eliminate themselves.*
Improvements since 1970 reflect substantial attention and resources. Similar attention and resources will be needed to address exposure disparities. If future emission-reductions follow historic patterns, then future improvements to exposures will continue to reduce average exposures (a good outcome) but maintain relative disparities. Eliminating disparities requires spatially targeted emission-reductions that clean the air especially for overburdened communities.

In light of these facts, aerosol researchers can play a valuable role by using data and models to investigate how to eliminate existing exposure disparities.

Plenary III: Lundgren-Marple Lecture

Synergies between Aerosol Measurements from Satellites and In-Situ at the Nose Level. VANDERLEI MARTINS, *Earth and Space Institute, University of Maryland, Baltimore*

The detailed measurement of aerosol microphysical properties from space provides unique capability for monitoring global aerosols on a daily basis. Multiple techniques are available spanning from LIDAR profiles to multi-angle, multispectral, and hyperspectral radiances measured in different polarization states. This wide variety of parameters provide multiple independent variables that can be inverted for the detailed inference of aerosol amount (optical thickness), particle size distributions, particle shape parameters, real and imaginary refractive indices, single scattering albedo, etc.

The same multi-angle and polarization techniques used on satellite measurements can also be used for in-situ measurements with a polarized polar nephelometer. The added synergy and advantages in having total column and surface measurements performed simultaneously, with the same technique, will be explored in this talk. In-situ measurements also bring the added advantage of allowing for aerodynamic separation, and for detailed chemical measurements, both of which we want to interpret together with the satellite total column measurements.

In this talk we will show the application of the Generalized Retrieval of Aerosol and Surface Properties (GRASP) inversion algorithm to retrieve aerosol microphysical properties from remote sensing as well as from in situ aerosol measurements. Specific results include laboratory measurements with different aerosol types, results from past field campaigns, remote sensing results from the HARP CubeSat and from the ADLER-2/GAPMAP satellites, as well as future measurements with the HARP2 sensor on the NASA PACE observatory. In particular, we will show results from two years of HARP CubeSat data collected around the globe, and results from the current GAPMAP sensor, which is still on Earth's orbit, including aerosol retrievals over dust and biomass burning smoke. In situ results will be discussed from multiple versions of integrating nephelometers, from the Polarized Imaging Nephelometer, and from the newly developed IMAP instrument, all measuring the optical and microphysical properties of aerosols.

Plenary IV

The Role of Aerosol Science in Understanding and Minimizing the Risk of Airborne Infection Transmission. LIDIA MORAWSKA, *Queensland University of Technology, Australia*

The term "prevention of infection transmission" evokes in most people an image of a white-clad medical professional, shielded from head to toe in personal protective equipment, while disinfecting, testing, or performing medical procedures on infectious patients. But apart from physicists and other scientists working in this field, few people realise that in fact physics, and more specifically aerosol physics, plays a major role in infection transmission. The interdisciplinary nature of the process of infection transmission makes it an immensely complex and interesting area to study, but also opens the door to misunderstanding and misinterpretation.

Understanding the numerous physical mechanisms involved in infection transmission is critically important in lowering the risk of infection transmission; this is where aerosol science comes to the fore. Yet the broader role of aerosol science is to interact and communicate with other scientific fields, particularly the medical community, to facilitate an understanding of the physics of the process in the "languages" of these disciplines. When the physics is understood, appropriate risk mitigation measures can be implemented according to the roles and responsibilities of these disciplines.

The problems start with the definitions of aerosol science terms. According to aerosol science, an aerosol is defined as "an assembly of liquid or solid particles suspended in a gaseous medium long enough to enable observation or measurement" (Kulkarni et al. 2011) . In contrast, medical science defines an aerosol as a small particle, while a droplet is a particle larger than 5 µm. Discussion about the terminology is still raging and dividing expert communities, so to help unite the fields, we propose to use the term particles, rather than aerosols or droplets, [Morawska and Buonanno, 2021]. But addressing the terminology is just the beginning. The next step is to develop a quantitative understanding of particle generation, particle emission, particle evaporation, particle flow dynamics, and particle disposition.

Particle generation occurs in the respiratory tract during human respiratory activities, which include breathing, speaking, singing, or coughing. After the particles are emitted, complex physico-chemical reactions occur as a result of particle evaporation in the air and flow dynamics drive the process of particle transport between the infected and a susceptible person. The final step is the disposition of the particles in the respiratory tract of the susceptible person, at which point the biological process of infection starts.

How well do we understand these processes? In our recent review on this topic [Morawska and Buonanno, 2021], we concluded that although the generation of particles in the respiratory tract is understood qualitatively, there is little quantitative knowledge about the characteristics of particles emitted during respiratory activities, their fate after emission, and their deposition during inhalation. More studies are clearly needed to address these knowledge gaps.

However, we should not discount the importance of what we actually do know, and how we can and should use this knowledge in lowering the risk of infection. I previously advocated for the use of our knowledge base to prevent infection after the SARS1 epidemic (Morawska, 2006). Since then, many studies using novel technologies have increased our understanding of the size distribution of particles from our respiratory processes and demonstrated that particles emitted from our respiratory activities can be suspended in the air for a long time and travel long distances in the indoor environment. A fraction of the virus contained by the particles remains infectious during this process (Oswin et al., 2022).

The hard lessons of the COVID pandemic have led to the realisation that as a society we have not effectively used the knowledge we already have. One of the key directions to follow to improve our future performance is to develop and legislate indoor air quality standards that include control of infectious respiratory particles emitted by building occupants. Our paramount argument continues to be that clean indoor air is a basic human right (Morawska, 2022).

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1AP.1

Surface Tension and Phase Transitions of Sea Spray Systems Using Microfluidics. CARI DUTCHER, Priyatanu Roy, Margaret House, *University of Minnesota*

Sea spray aerosols (SSA) are comprised of particles and droplets with chemically complex microphysical properties, with composition and phase that can evolve dramatically with changes in the ambient environmental conditions. The resultant composition and phase inform the particle’s optical properties, water uptake and partitioning, and activation to cloud condensation or ice nuclei. In this work, recent advancements using laboratory microscale flows will be highlighted for marine based droplet systems through NSF Center for Aerosol Impacts on Chemistry of the Environment (NSF CAICE) collaborations, towards improved understanding of the properties and phase of sea spray aerosols in our atmosphere. Microfluidics offers the advantage of rapid and monodisperse droplet generation with precise temperature control. Microscale tensiometry methods for determining equilibrium and dynamic surface tension will be presented for aqueous systems containing soluble surfactants, using an array of expansion-contraction geometry. Discussion of surfactant transport with flowing bubbly systems, including diffusion and surface adsorption mechanisms, will be provided. Microfluidic methods for measuring droplet phase transitions, including liquid-liquid phase separation and ice nucleation (IN), will also be highlighted. Temperature and relative humidity dependence of the phase transitions for model chemical systems along with bulk and sea surface microlayer sea water samples obtained from a simulated waveflume experiment through NSF CAICE partnerships are studied in static and high-throughput droplet microfluidic platforms. Discussion of analysis methods and automated detection and classification of frozen droplets using machine learning will also be provided.

1AP.2

The Drying Kinetics and Crystallisation of Multi-Component Droplets. BARNABY MILES, Lukesh Mahato, Daniel Hardy, Spyridon Varlas, Steven P. Armes, Rachael E.H. Miles, Jonathan P. Reid, *University of Bristol*

Understanding the drying kinetics of aerosol droplets is crucial in improving many industrial products, notably spray dried pharmaceuticals and foods, advancing climate models, and quantifying and mitigating airborne disease transmission. Changes in environmental conditions such as temperature and relative humidity (RH) influence the droplet-drying processes which impacts the final dry particle morphology. This, in turn, determines the aerodynamic and dissolution properties of the dry particles. Here, we present novel investigations into the impact of environmental factors on the evaporation and crystallisation of both multi-component aqueous inorganic salt droplets and colloidal droplets. Droplet evaporation profiles measured using an Electrodynamic balance (EDB) are compared to a model implementation for coupled heat and mass transport from solution droplets (SADKAT). Droplets dried using a falling droplet column (FDC) were collected and imaged using Scanning Electron Microscopy (SEM). Through varying the environmental relative humidity we demonstrate for both droplet systems how the evaporation rate, and hence, efflorescence time of these aerosol droplets, can be controlled. We further present details of the relationship between crystallisation time, droplet composition and resultant particle morphology.

For the inorganic salt droplets, we also show how altering the molar ratios of the component inorganic salts impacts the effect of relative humidity on the drying kinetics. Including comparisons to the drying kinetics of the constituent inorganic salts as single component droplets. We further present the composition of the dried aerosol particles as identified by SEM-EDX analysis and compare these to the compositions thermodynamically predicted by E-AIM.

For the colloidal droplet drying, we show how altering the size of the component nanoparticles in the colloidal droplet impacts the morphology of the resultant particle.

1AP.3

Light-Absorbing Aerosol-Cloud Interactions. SHREYA JOSHI, Claudio Mazzoleni, Lynn Mazzoleni, Will Cantrell, Raymond Shaw, Simeon Schum, Thusitha Divisekara, Ian Helman, Abu Sayeed Md Shawon, Kyle Gorkowski, Timothy Onasch, Arthur J. Sedlacek, Yangang Liu, Laura Fierce, Swarup China, Nurun Nahar Lata, Gourihar Kulkarni, *Michigan Technological University*

Atmospheric light-absorbing aerosols, including those containing black carbon (BC) particles, play a critical role in determining Earth's radiation budget. These particles interact with solar radiation by scattering and absorbing light, as well as with clouds. However, the pathway by which BC-containing particles evolve in the atmosphere and internally mix with other substances, such as organics,significantly impacts their light scattering and absorption capabilities, as well as their interactions with clouds. Despite some prior research in this area, the effects of BC-cloud interactions have not received sufficient attention. Light-absorbing aerosol-cloud interactions (LAACI) is a project designed to investigate these processes using the Michigan Tech cloud chamber (the Pi Chamber). We utilized a BC surrogate (cab-o-jet) and a coating material surrogate (liquid smoke) to understand better some aerosol-cloud interactions. Notably, commercially available Liquid Smoke (LS) aerosols proved to be a suitable surrogate, chemically as well as physically, for non-refractory biomass burning aerosols to be employed as coating material on BC particles. We developed a procedure to coat particles comprised of the BC surrogate with LS. Cloud experiments employed a Pumped Counterflow Virtual Impactor (PCVI) to investigate changes in the morphology, optical, and chemical properties of the pure and coated BC residuals (particles that were activated at the time of sampling) and the interstitials (particles that were not activated at the time of sampling). Throughout these experiments, we monitored alterations in the optical and cloud condensation nuclei properties of both interstitial and residual particles, comparing them with the properties of the same particles before their introduction into the Pi-Chamber. In our experiments we saw that LS aerosols have a higher critical supersaturation for activation after its interaction with clouds in the Pi Chamber. It was also seen that for coated BC the residuals have different optical properties from the interstitial, the former being more absorbing than the latter.

1AP.4

The Impact of Inelastic Collisions on the Mean Free Path in Air. DIMITRIOS TSALIKIS, Vlasis Mavrantzas, Sotiris Pratsinis, *ETH Zurich, Switzerland*

The mechanics of molecular collisions in air are investigated by thoroughly-validated atomistic molecular dynamics that treat oxygen and nitrogen as true diatomic molecules accounting for their shape and force field, for the first time to our knowledge. Most of these collisions involve two molecules, but few involve three and even four molecules, a direct result of accounting for their force field and non-spherical shape. Furthermore, colliding molecules can spend appreciable time together before splitting apart, resulting in even spurious collisions when they briefly separate and collide repeatedly without interacting with any other molecule. By excluding such collisions through Hazard plot analysis and systematically recording the distribution of molecular free paths (distance traveled between collisions), the mean free path, λ, in air is determined as 38.5 ± 1 nm at 300 K and 1 atm. This is about 43 % smaller than the 67.3 nm widely accepted λ value today at these conditions in textbooks from the classic kinetic theory of gases. Accounting only for their force field (Lennard-Jones) but assuming spherical oxygen and nitrogen molecules yields a λ of 42.3 ± 1.1 nm, again about 37% smaller than that from kinetic theory. So, accounting for the force field of the molecules is more important than their shape, which is not insignificant either.

1AP.5

Particle Tracking in Turbulent Transonic Flow Field. SREEKESH KOOKKAL, Suresh Dhaniyala, *Clarkson University, Potsdam, NY*

Transonic flow fields are commonly encountered in pressure reduction systems such as critical orifices and in sampling systems on high speed aircraft. Under such conditions flow field calculation is made using Reynolds Averaged Navier-Stokes (RANS) technique. Particle trajectory calculations are generally made using Lagrangian Particle Tracking (LPT) coupled with discrete random walk (DRW) model, where instantaneous velocity is calculated as sum of mean velocity and fluctuating velocity. Conventional DRW models in commercial RANS codes such as ANSYS FLUENT tend to overpredict particle loss due to turbulence in channels and under-predict the role of turbulence in high-speed flow. Here, we use a modified DRW approach that accounts for fluctuating velocity calculated from the RMS turbulence velocity fluctuations and a drift velocity correction term. The drift velocity correction term includes the gradient of Lagrangian time scale and velocity, accounting for particle inertial interaction with turbulent eddies. We evaluate the performance of this improved DRW for three flow conditions: turbulent flow in a channel, flow through a critical orifice, and non-critical flow through an aerosol skimmer system. The numerical predictions are compared against experimental measurements for the three cases. The results from our improved DRW compared to that obtained with conventional DRW will be presented.

1AP.6

The Bidimensional Size and Charge Distribution of Sub- and Supermicrometer Particles in an Electrostatic Precipitator. JOSÉ MORÁN, Li Li, Hui Ouyang, Yuechen Qiao, Bernard Olson, Christopher J. Hogan, *University of Minnesota*

Unipolar charging plays an important role in aerosol particle measurements, and filtration through electrostatic precipitators (ESP). Previous numerical works have been limited in terms of the available experimental data regarding particle charge distribution. Such a distribution has been previously measured in the literature for monodisperse nanoparticles (Biskos et al. 2005) and to the best of the authors' knowledge, only a few remarkable works (Järvinen et al., 2017) have discussed the determination of the bidimensional particle size-charge distribution. Here we have formulated, solved and experimentally implemented two different techniques to reveal the aerosol particle size and unipolar charge distribution experimentally accounting for the instrument transmission and penetration efficiencies. These techniques include the tandem differential mobility analyser (TDMA) for particles in the 50-250 nm diameter range, and a combined DMA-aerodynamic particle spectrometer (APS) for particles in the 0.3-20 µm diameter range. To this end, we have designed a bench scale ESP and mounted inline into a single-pass wind tunnel (Ouyang et al., 2022) operated at 566.3 and 849.5 L/min flowrates. Aerosol particles are produced by atomizing a KCl liquid solution at 0.3 mL/min which produces particles in the 0.05 to 10 µm diameter range. These particles are carried by the flow in the tunnel and charged in the ESP operated at positive polarity with voltages ranging between 11 to 14 kV which produces a corona discharge between 9 to 84 µA. Particles are sampled downstream and upstream the ESP to study their collection efficiency and their bidimensional size-charge distribution.

For a fixed particle size, the unipolar charge distribution shows a single peak which is accurately fitted by a Gaussian distribution. Interestingly, the mean and standard deviation of this Gaussian distribution follow a positive correlation with the diameter of particles. The average charge scales in a power-law with the particle diameter with exponents between 1.29 to 1.39 depending on the ESP voltage and flowrate in the wind tunnel. In addition, we have developed a 1-dimensional model considering particle unipolar charging through diffusion and field charging mechanisms. Considering the fitted electric field strength and ion number concentration, this model is able to predict the collection efficiency curves of the ESP along the whole range of particle size and the trend of the average charge as a function of the particle diameter with reasonable accuracy.

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1AP.7

Effects of Dilution on Biomass Burning Aerosol: Evaporation of Primary Organic Aerosol (BBPOA) and Subsequent Formation of Secondary Organic Aerosol (BBSOA).

TIANCHANG XU, Nara Shin, Yutong Liang, Bin Bai, Dongli Wang, John Allen, Ryan Poland, Zachary McQueen, Omar El Hajj, Chase Glenn, Kruthika Kumar, Anita Anosike, Joseph O'Brien, Andrew Metcalf, Geoffrey Smith, Rawad Saleh, Pengfei Liu, Nga Lee Ng, *Georgia Institute of Technology*

Biomass burning is a major contributor of gaseous and particulate carbon in the atmosphere, with significant impact on air quality, health, and climate forcing. Biomass burning events can result in both emission of primary organic aerosol (POA) and formation of secondary organic aerosol (SOA). Previous studies have proposed that dilution-driven BBPOA evaporation and subsequent BBSOA formation can account for up to one third of biomass burning organic aerosol (BBOA) in the atmosphere, in which a higher dilution ratio will lead to a higher potential of BBSOA formation from BBPOA. However, the chemical composition of the evaporated BBPOA and subsequent BBSOA is not well characterized owing to the chemical complexity of biomass burning plumes. In this work, we systematically investigate the relationship between BBPOA evaporation and BBSOA formation in the Georgia Wildland-fire Simulation Experiment (G-WISE) campaign. The G-WISE campaign involved burning fuel beds constructed using forest floors and surface fuels collected from three ecoregions in Georgia. The biomass burning aerosol is diluted with a dilution ratio of 3:1 to 15:1 and then passed through an oxidation flow reactor (OFR) to allow for measurement of both fresh POA (lights off condition) and SOA (lights on condition). The chemical composition of OA is measured by a high-resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS) and a Filter Inlet for Gases and AEROsol (FIGAERO) inlet system coupled with an iodide HR-ToF-CIMS. It appears that higher dilution ratios lead to increased prevalence of organic acid (e.g., glycolic acid and lactic acid) and phenol derivative (e.g., syringic acid) in BBSOA, indicating the role of dilution ratio on SOA formation pathway. Results from this study highlight the complexity in the evolution of BBOA, especially on BBPOA fate and BBSOA formation pathway.

1CO.1

A Planar Mixing Layer (PML) Configuration to Perform Spatially Resolved High-Resolution Differential Mobility Analysis (HR-DMA) in Diffusion Flames.

Mahmoud Ashour, FARNAZ KHOSRAVI, Francesco Carbone, *University of Connecticut*

The unraveling of soot inception in non-premixed flames is an unsolved challenge that may further the understanding of soot formation in real combustion applications. Over several decades, the Axysimentric coFlow (AcoF) and Counterflow (CF) canonical flame configurations have been invaluable for studying many aspects of soot formation in diffusion flames. However, the steep gradients and the small sizes of the flame these canonical configurations can stabilize made them incompatible with the use of dilution probes necessary to implement aerosol diagnostics. To address this problem, we introduced the Planar mixing Layer (PML) by modifying the original Wolfhard-Parker burner design which consists of two adjacent planar nozzles, one yielding the fuel and the other the oxidizer, both surrounded by a nitrogen flow to shield the reactants from surrounding air. The flame is stabilized near the Mixing Layer Interface (MLI) between the reactants within the boundary layer which grows at increasing Height Above the Burner (HAB) until buoyant instabilities disrupt the steadiness of the flow. The PML novelty consists of the flow stabilization achieved by installing a plate downstream of the burner nozzles, which is equipped with an exhaust slit for evacuating the hot flame products. Buoyancy anchors the flame in the middle of the slit and keeps the flow laminar and steady at large HABs so that a flat and approximately 10mm thick flame can be stabilized. The geometry enables the implementation of intrusive sampling of the PML flame products without limitations related to the spatial resolution of the results. This work reports the first spatially resolved measurements of the PML flame products performed using High-Resolution Differential Mobility Analysis (HR-DMA). The results show that soot nucleation occurs in the proximity of the maximum temperature and is followed by growth taking place while the materials are advected towards the MLI at progressively lower temperatures.

1CO.2

Secondary Organic Aerosol Formation Potential of Toluene and Products of Toluene Combustion. ANITA ANOSIKE, Omar El Hajj, Chase Glenn, Nicholas Dewey, Brandon Rotavera, Rawad Saleh, *University of Georgia*

Gasoline engines are major sources of secondary organic aerosol (SOA) precursors. However, the relative contribution of these precursors from evaporative emissions (unburned fuel) versus tailpipe emissions (incomplete combustion) is still under debate. To address this gap, we investigated SOA formation from toluene and from emissions of toluene combustion at different combustion temperatures. Single-ring aromatics are responsible for the majority of SOA from evaporative emissions, therefore toluene is an appropriate surrogate for this investigation.

The experiments involved flowing toluene and air through an atmospheric-pressure reactor controlled at temperatures ranging between 293 K and 1123 K to capture evaporative emissions (lower temperatures) and partially burned fuel emissions (higher temperatures). The emissions were then diluted, passed through a PTFE filter to remove carbonaceous particles formed during combustion, and sent through an oxidation flow reactor (OFR) to initiate SOA formation from oxidation with OH radicals. The OH exposure in the OFR corresponded to an equivalent photochemical age of 1.5 days.

The SOA concentrations were stable for temperatures between 293 K and 850 K, and increased with increasing temperature reaching approximately a five-fold increase at 1123 K. This temperature-dependent SOA formation profile is consistent with the temperature-dependent toluene reactivity obtained using ChemKin simulations. These results indicate that products from incomplete combustion of toluene, including polycyclic aromatic hydrocarbons (PAHs), have higher SOA formation potential than toluene.

We performed chemical analysis on SOA samples collected at reactor temperature of 293 K and 1123 K using ultra-high resolution electrospray ionization mass spectrometry. Mass spectra of both samples exhibited repetitive peaks characteristic of oligomer formation. The average molecular formulae were $C_{16.0}H_{17.9}O_{9.5}$ and $C_{16.0}H_{16.7}O_{9.3}$ for the 293 K and 1123 K cases, respectively.

In summary, incomplete combustion products had higher SOA formation potential compared to unburned toluene, but the SOA from the two emissions retained similar chemical composition.

1CO.3

High-Temperature Hydrocarbon Clustering and Particle Inception. HOPE MICHELSEN, James Rundel, Ray Bambha, Judit Zádor, K. Olof Johansson, Paul Schrader, Kevin R. Wilson, *University of Colorado, Boulder*

Soot is formed during the incomplete combustion and pyrolysis of hydrocarbon fuels and has an enormous impact on human health and the environment. It is responsible for a majority of the more than 7 million premature deaths attributed to air pollution worldwide annually, and it is the second leading cause of global warming. Despite its ubiquity, the chemical pathways leading to its formation are shrouded in mystery. We hypothesize that radical chain reactions driven by resonance-stabilized hydrocarbon radicals are responsible for particle inception. We have performed targeted experiments to explore and test this hypothesis. Vacuum-ultraviolet aerosol mass spectrometry (VUV-AMS) has provided a wealth of information about the species involved in particle inception. VUV-AMS measurements of particles formed during pyrolysis have demonstrated that temperatures at which particles are influenced by the availability of resonance-stabilized radicals. In this talk, we present evidence for clustering of hydrocarbons driven by reactions initiated by such radicals.

1CO.4

Rapid Assessment of Jet Engine-Like Soot from Jet-A1 and Sustainable Aviation Fuels Made by a Spray Flame. Jason Scott, TIMOTHY SIPKENS, Rym Mehri, Gregory Smallwood, Mohammad Reza Kholghy, *National Research Council Canada*

Black carbon, or soot, is one of the highest contributors to global warming. Soot is classified as a non-volatile particulate matter (nvPM), and the International Civil Aviation Organization (ICAO) is continually evolving their restrictions for jet engine emissions to combat the effects of harmful nvPM on the environment. Sustainable aviation fuels (SAFs) offer advantages to reduce soot emissions and overall environmental impact but require extensive testing and evaluation before wider adoption. Typical measurements of soot produced by aviation fuels require full-sized jet engines and large volumes of fuel, which can be prohibitively expensive. This study investigates flame spray pyrolysis (FSP) as a simple bench-top tool for comparison of soot emissions from different liquid jet fuels. A sampling assembly is designed for soot collection and analysis. Morphological analysis follows from TEM image analysis and combined mobility (differential mobility analyzer) and mass (centrifugal particle mass analyzer) classification. Morphologies are compared to previous measurements from aircraft turbines. Soot agglomerate size distributions and elemental to total carbon ratios (EC/TC) are measured for three liquid fuels and flame conditions with Reynolds numbers and burner equivalence ratios ranging from 6100 to 9100 and 7 to 13, respectively. Day-to-day variations in the dilution ratio resulted in up to 20% variability in the measured total agglomerate number density and mobility diameter. Geometric mean primary particle and mobility diameter values are below 21 and 113 nm, respectively, in excellent agreement with those emitted from jet engines and earlier works using FSP. EC/TC remains > 0.75 for most flame conditions and fuels and increases with burner equivalence ratio, but values as low as 0.63 are measured from SAFs.

1CO.5

Soot Size Distribution & Structure during Enclosed Spray Combustion of Jet Fuel. UNA TRIVANOVIC, Georgios A. Kelesidis, Sotiris Pratsinis, *ETH Zurich, Switzerland*

Aircraft engines are significant sources of soot that have inflammatory and cytotoxic responses [1] and contribute to global warming through direct radiative forcing [2] and indirectly by facilitating formation of ice nuclei and contrail cirrus clouds [3]. The characteristics of aircraft soot vary drastically with the applied thrust [4]. So, understanding the relation between combustion conditions, soot primary particle diameter, d_p and nanostructure is essential to quantify and mitigate the impact of such emissions on climate change and public health. Here, the evolution of soot d_p and nanostructure is monitored during enclosed spray combustion (ESC) of jet A1 fuel at various Effective eQuivalence Ratios (EQR) for ESC's capacity to match the size and composition characteristics of soot from aircraft engines [4]. The soot nanostructure can be characterized by the Raman ratio of the soot disorder (D) over graphitic (G) band, as well as the crystallite length, L_c, and interlayer distance, d_{002}, of soot from X-Ray diffraction. As EQR increases from 1.46 to 1.88, the soot d_p increases from 14 to 23 nm due to enhanced surface growth [5], while D/G decreases from 0.9 to 0.8. This indicates that small soot nanoparticles have a more disordered structure than larger ones, consistent with such soot data from an inverted burner [6] and a laboratory gas flare [7]. As soot d_p increases, its d_{002} (circles) decreases while the L_c (triangles) increases. This confirms that small soot nanoparticles have fewer layers per crystal which are also less densely packed than larger ones resulting in a more disordered structure, corroborating Raman measurements, for the first time to the best of our knowledge [8]. Additionally, the ordered nanostructure of the large particles lowers their oxidation rate increasing their light absorption [9] that affects both of their cytotoxicity and radiative forcing of soot as stated above.

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1CO.6

Eliminating Soot Emissions from Jet Fuel Combustion.

GEORGIOS A. KELESIDIS, Amogh Nagarkar, Una Trivanovic, Sotiris Pratsinis, *Rutgers, The State University of New Jersey*

Soot from jet fuel combustion in aircraft engines contributes to global warming through the formation of contrail cirrus clouds that make up to 60 % of the total radiative forcing from aviation. Here, the elimination of such emissions is explored through gas injection (containing 0 - 25 vol % O_2) at the exhaust of enclosed spray combustion of jet fuel that emulates nicely aircraft soot emissions (doi.org/10.1080/02786826.2022.2070055). It is shown that injecting gas containing 5 vol % of O_2 enhances the formation of polyaromatic hydrocarbons (PAHs) that adsorb on the surface of soot. This increases its number density and volume fraction by 25 and 80 %, respectively. Further increasing the O_2 concentration to 20 or 25 vol %, however, enhances oxidation (doi.org/10.1016/j.combustflame.2019.08.001) and nearly eliminates soot emissions from jet fuel spray combustion, reducing their total number density and volume fraction by 87.3 or 95.4 and 98.3 or 99.6 %, respectively! The reduction of soot emissions attained here is up to 60 % higher than that by blending jet fuel with alternative ones. So, injection of air just after the aircraft engine exhaust can reduce the radiative forcing from their emissions by 50 %.

1CO.7

Continued Role of Oil and Sulfur in Ground-based Aircraft Engine Particle Emissions during the Boeing ecoDemonstrator 2022 Measurements. BENJAMIN A. NAULT, Andrew Freedman, Edward Fortner, Bruce Anderson, Steven Baughcum, Matthew Brown, Josh DiGangi, Francisco Guzman, Jennifer Klettlinger, Kevin Sanchez, Michael Shook, Gregory Smallwood, Elizabeth Wiggins, Edward Winstead, Luke Ziemba, Richard Miake-Lye, Richard Moore, *Aerodyne Research, Inc.*

Advancements in technology and fuel sources have led to reductions in the non-volatile and volatile particle emissions from aircraft gas turbine engines. To understand these changes, particle and trace gas emissions were sampled on the ground at 56 m behind two different engines during the 2022 Boeing ecoDemonstrator project located at Boeing Everett Airfield in Everett, WA, USA. Four different fuels were investigated, including 100% sustainable aviation fuel (SAF), petroleum-based Jet A fuel, petroleum-based Jet A low sulfur fuel, and a SAF blend. Chemical composition of the non-volatile and volatile particles was measured by an Aerodyne Aerosol Mass Spectrometer (AMS); black carbon (BC) was measured using an Aerodyne CAPSSSA monitor operating at 630 nm.

The measurements showed two trends for volatile organic aerosol (OA). When oil was intentionally removed from the emissions, the volatile OA contributed minimal mass and minimal fractional contribution to the total aerosol carbon (OA + BC) as aircraft thrust increased. However, when oil was not removed from the emissions, volatile OA increased with engine thrust. The increase in OA mass concentration led to increases in the OA contribution to total aerosol carbon.

Further, sulfur aerosol was consistently above the background sulfur mass concentration. This indicated that even for fuels with low sulfur, there was still enough sulfur to contribute to volatile aerosol. However, as sulfur contribution has decreased, the nitrate contribution appears to be increasing. Impacts on sulfur overall decreases will be discussed.

The combination of sulfur, nitrate, and oil aerosol will have impacts on the physicochemical properties of aerosol both at ground level and at altitude, which is still under investigation.

Finally, multiple measurements of BC were conducted during the 2022 Boeing ecoDemonstrator project. A comparison of these BC measurements and the resulting BC emissions data will be discussed.

1HA.1

Evaluating Inflammatory Responses of Naphthalene Secondary Organic Aerosol (SOA). SEONGBIN JO, Liang-Hsin Chen, Shuichi Takayama, Nga Lee Ng, *Georgia Institute of Technology*

Naphthalene is one of the polycyclic aromatic hydrocarbons (PAHs) that are commonly found in the environment. Naphthalene from anthropogenic emissions can react with atmospheric oxidants to form secondary organic aerosol (SOA). Naphthalene has been identified as a potent carcinogen and an immunotoxicant by activating aryl hydrocarbon receptors (AhRs). However, the immunotoxicity of SOA derived from naphthalene in a physiologically relevant model has not been studied owing to the complex chemical properties of SOA. Here, we conduct a series of laboratory experiments that involve formation of SOA from naphthalene and investigation of SOA toxicity using the air-blood barrier array (ABBA) module. The ABBA module mimics the human lungs epithelium and endothelium interface, allowing for examination of the cell-cell interactions in the lung barriers to fully investigate the inflammatory responses of naphthalene SOA exposure. First, we generate naphthalene SOA under different NOx conditions in photooxidation experiments. The chemical composition of the naphthalene SOA is characterized by high-resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS) and filter inlet for gas and aerosols time-of-flight chemical ionization mass spectrometer (FIGAERO-ToF-CIMS). Then, we use the ABBA module to investigate the naphthalene SOA-induced reactive oxygen species (ROS) and interleukin-8 (IL-8) production at the epithelium and the endothelium interface, which represent the initiation and mediation of inflammatory cascades from naphthalene exposure to the epithelial cells and subsequent responses in the endothelial cells. The measured inflammatory responses can demonstrate the series of immunotoxic responses leading to the degradation of lung barrier function.

1HA.2

Cellular and Molecular Toxicity of Atmospherically Aged Anthropogenic and Biogenic Aerosols in an Epithelial-Endothelial Coculture Using Adverse Outcome Pathways as Risk Assessment. SVENJA OFFER, Sebastiano Di Bucchianico, Hendryk Czech, Michal Pardo, Rasha Alsaleh, Christian Kersch, Simone Schmitz-Spanke, Yinon Rudich, Ralf Zimmermann, AeroHealth Team , *Helmholtz Zentrum München*

Secondary organic aerosols (SOA) formed from anthropogenic and biogenic volatile precursors substantially contribute to the fine particulate matter ($PM_{2.5}$) burden, which has been associated with adverse human health effects. However, the molecular and cellular effects of atmospheric aging processes remain largely unknown. In this work, we aimed to elucidate the complexity of atmospheric aerosol toxicology by applying controlled model aerosols for realistic in vitro exposure at the air-liquid interface in a multicellular lung tissue model.

To achieve this goal, we generated aerosols by atmospheric aging of volatile biogenic (β-pinene) or anthropogenic (naphthalene) model precursors of SOA that condensed on soot particles. In-depth physicochemical characterization revealed similar physical properties and distinct chemical composition of generated SOA aerosols. The anthropogenic SOA was associated with the formation of more oxidized and more aromatic organic species with a higher oxidative potential and a greater extent of unsaturated carbonyls compared to biogenic derived SOA.

We discriminated the induced toxicological effects by exposing the multicellular model system, consisting of a lung epithelial cell line (A549) and an endothelial cell line (EA.hy926) in a 3D orientation. At a functional level, anthropogenic SOA largely augmented the secretion of the proinflammatory cytokine IL8 and the oxidative stress marker malondialdehyde compared to the biogenic SOA. Moreover, naphthalene-derived SOA significantly induced primary (A549) and secondary (EA.hy926) genotoxicity as well as the cross-activation of endothelial cells (angiogenic potential). Integrated transcriptomic and metabolomic analysis revealed an induction of stress-related airway remodeling in A549 cells and the involvement of pathways for intracellular signal transduction (PI3K/AKT) and endothelial dysfunction (iNOS; PDGF) in EA.hy926 cells, especially after exposure to the anthropogenic SOA. This mechanistic information was used to describe an adverse outcome pathway framework supporting a pivotal role of PM chemical composition in toxicological outcomes.

1HA.3

Combustion Conditions Influence Physiochemical Properties and Cytotoxicity of Flame-Generated Soot to Ocular (ARPE-19) and Lung (A549) Cells.

DHRUV MITROO, Durgesh Das, Paul Hamilton, Benjamin Kumfer, Nathan Ravi, *Veterans Research and Education Foundation*

Soot forms due to incomplete combustion and typically refers to the carbonaceous aerosol produced by a flame. Many sources of soot exist. Depending on the source and combustion condition, the resulting soot bears different physicochemical properties. As a laboratory equivalent of soot, carbon black or commercial ink powders have been used. Both physical and chemical properties of such nanoparticles do not capture those of real soot. Moreover, a range of properties is not readily available. Bench-scale soot generators have been proposed to reproduce a more realistic soot model, with the setup consisting of a way to manipulate the flame properties to controllably reproduce different types of soot.

We developed such a system based using ethylene gas. Our system can switch between premixed and non-premixed modes while online. We have begun characterization of the physicochemical properties of the resulting soot and collected samples for in-vitro toxicity studies. We are targeting the eye and the lung using ARPE-19 (ocular; human retinal pigment epithelial cells) and A549 (pulmonary; adenocarcinomic human alveolar basal epithelial cells) tissue culture cells. Soot particles produced in premixed flames are generally smaller in size, exhibit a lesser fractal structure, and are considerably more toxic to cells than soot particles produced in non-premixed flames. In premixed flames, we find that soot toxicity increases with increasing oxygen concentration in the fuel-rich premixed flame feed, and weakly increases with decreasing flame temperature. We attribute this mostly to increased amorphous carbon compared to graphitic carbon.

Compared to control cells, we find increased presence for proteins indicative of apoptosis, such as Cytochrome C, with exposure to soot. We also find increased presence of other proteins indicative of DNA damage, such as Poly (ADP-ribose) polymerase (PARP), with exposure to soot. This is a step in understanding how properties of soot influence the proteome.

1HA.4

The Effect of Atmospheric Aging on the Toxicity of Bare and Coated Soot Particles.

YINON RUDICH, Michal Pardo, Hendryk Czech, Svenja Offer, Sebastiano Di Bucchianico, Astrid Kiendler-Scharr, Ralf Zimmermann, AeroHealth Team , *Weizmann Institute of Science*

Soot particles (SP) are ubiquitous components of atmospheric particulate matter. They are known to cause adverse health effects. In the atmosphere, freshly emitted SP can be coated by condensed low-volatility secondary organic and inorganic species. In addition, gas-phase oxidants may react with the surface of soot particles. We investigated the biological responses of lung epithelial cells following exposure to fresh- and photochemically aged-SP at the air–liquid interface. In addition, we studied how coating SP by biogenic and anthropogenic model SOA affects SP toxicity. A comprehensive physical and chemical aerosol characterization was performed to depict the atmospheric transformations of bare SP, showing that photochemical aging increased the organic carbon fraction and the oxidation state of the SP. We will present RNA-sequencing and qPCR analysis showing varying gene expression profiles for fresh-, aged- and coated SP. Exposure to aged- SP increased DNA damage, oxidative damage, and upregulation of NRF2-mediated oxidative stress response genes compared to fresh SP. Furthermore, aged-SP augmented inflammatory cytokine secretion and activated AhR-response, as evidenced by increased expression of AhR-responsive genes. These results indicate that oxidative stress, inflammation, and DNA damage play a vital role in the cytotoxicity of SP in lung epithelial cells, where aging leads to higher toxic responses. Our results suggest that photochemical aging increases SP toxicity through surface modifications that lead to an increased toxic response by activating different molecular pathways. Coating by SOA and atmospheric aging further increases SP toxicity. This work was partially funded by the Helmholtz International lab AeroHealth and the Weizmann Institute.

1HA.5

Impact of Electronic Cigarette Settings on Primary and Secondhand Aerosol-Induced Toxicity: Evaluating Cell Survival and Membrane Stability.

KAPIAMBA KASHALA FABRICE, Hsin-Yin Chuang, Weixing Hao, Lung-Chi Chen, Yue-Wern Huang, Yang Wang, *University of Miami*

In this study, we investigated the impact of primary and secondhand electronic cigarette (EC) aerosols on the viability and membrane integrity of human lung adenocarcinoma A549 cells. The transepithelial electrical resistance (TEER) of air-liquid interface (ALI) cultures was measured to assess cell membrane integrity following exposure. The study compared the effects of nicotine concentration (0 mg/ml and 6 mg/ml) in the e-liquid and EC power settings (10W and 60W). Significant cell death was observed in cells exposed to primary and secondhand aerosols generated by both tested brands at the default power setting and 10W, regardless of nicotine concentration in the e-liquid. To evaluate the sole effect of power, the study examined e-liquid with no nicotine and found a 73 ± 3% cell viability (compared to the control) for samples exposed to aerosols generated at 10W ($p < 0.05$, $N = 6$). At higher power settings of 35W and 60W, cell viabilities dropped to 45 ± 1% and 42 ± 2%, respectively.

Using e-liquid with 6 mg/ml, nicotine yielded similar results, with a significant decrease in cell viability observed for samples exposed to aerosols generated at high EC power settings (35W and 60W). Notably, at 60W, cell viability was significantly lower for the 6 mg/ml nicotine concentration compared to the 0 mg/ml concentration. Similar trends were observed for TEER values (24 h after exposure), except for the effect of nicotine at higher power settings. The study's findings suggest that exposure to secondhand aerosols from ECs may pose potential health risks to bystanders. Compromised cell membrane integrity may permit harmful agents in EC and vaping smokes to penetrate subepithelial tissues, resulting in lung damage, immune system modulation, and disease progression.

1HA.6

Assessing the Respiratory Toxicology of E-cigarette Aerosols under Real-Use Patterns and Exposure Doses Using an Artificial Lung System.

HAOXUAN CHEN, Airi Harui, Yu Feng, Michael D. Roth, Yifang Zhu, *University of California, Los Angeles*

Despite several in vitro and in vivo studies suggesting the potential toxicity of e-cigarette (e-cig) aerosols, the actual health risks of using e-cigs remain poorly understood, partially due to the current toxicology testing method cannot accurately represent the inhalation exposure that happens in human lungs. To better understand the respiratory toxicology of e-cig aerosols under real-use patterns and exposure doses, we developed an artificial lung system that consists of a 6-L lung chamber with a 3D-printed human airway structure. The artificial lung can continuously breathe (i.e., inhale and exhale) with the temperature and humidity independently controlled to approximate human lungs. Additionally, the system integrates programmable e-cig puffing cooperating with the artificial lung's inhalation, enabling the simulation of various e-cig using patterns, including varying puff volumes and vaping frequencies.

By integrating the air-liquid-interface (ALI) culture of primary human bronchial epithelial (HBE) cells into the lung chamber, we have successfully conducted an e-cig exposure experiment for a total of 108 puffs for seven hours per day over two consecutive days. Our results show that the mitochondrial membrane potential of HBE cells in the air control and e-cig exposure groups are comparable. In contrast, the e-cig exposure group shows moderately elevated inflammatory responses, as suggested by several pro-inflammatory biomarkers. Ongoing studies will characterize the exposure doses of e-cig aerosols when the artificial lung is either ventilated or unventilated. In addition, we will comprehensively characterize and compare the respiratory toxicity of e-cig aerosols from e-liquid of different formulations by evaluating cytokine/chemokine productions and RNA expressions.

This study offers novel insights into the respiratory toxicology of e-cig aerosols under real-use patterns and exposure doses, as well as an innovative in vitro exposure system that can replicate typical exposure scenarios for various aerosols.

1HA.7

Development of a High-throughput Cellular Analysis Platform for Monitoring Particulate Matter Toxicity. ANNA KAEHR, Fobang Liu, Guillaume Aubry, Hang Lu, Nga Lee Ng, *Georgia Institute of Technology*

Exposure to particulate matter (PM) pollution is one of the top environmental risk factors affecting public health. Adverse health effects to PM exposure have been linked to oxidative stress, inducing downstream inflammatory response and cell damage. Studies on the impact of diverse PM chemical composition on cellular toxicity have been limited because many cellular assays are low-throughput and challenging to implement in large-scale screening efforts due to their time and resource intensiveness. To better evaluate cellular responses to PM exposure, we have developed a high-throughput microfluidic platform with low sample consumption and high reproducibility in PM delivery across multiple orders of magnitude of PM mass. Additionally, we have implemented a streamlined image analysis workflow that identifies cells and quantifies their oxidative stress response with high accuracy. With this pipeline, we can conduct parallel analyses of hundreds of cells exposed to the same condition for statistical power in detecting differences in cellular response upon exposure to PM of varying dose and composition. We validated the performance of our platform against a conventional well plate-based exposure system to show the utility of our microfluidic exposure model. This new technology serves to increase the feasibility of cellular toxicity screening for predicting adverse health effects from PM exposure.

1IM.1

Detection of Refractory and Nonrefractory Aerosol Mixtures Using the Dual-Vaporizer Configuration of the Soot Particle Aerosol Mass Spectrometer (SP-AMS). ANITA AVERY, Leah Williams, Edward Fortner, Timothy Onasch, *Aerodyne Research, Inc.*

The Soot Particle-Aerosol Mass Spectrometer (SP-AMS) can operate with one of two particle vaporizers: (1) the standard AMS resistively heated tungsten vaporizer for traditional detection of non-refractory particulate matter (NR-PM), and (2) an intracavity laser vaporizer for detection of absorbing, refractory materials, including refractory black carbon (rBC). Measurements of both refractory and non-refractory compounds can be achieved by sequentially turning the laser vaporizer on and off over the course of sampling. The nonrefractory component of internally mixed aerosols is detected in both laser states, but with different collection efficiencies (CE) and different relative ionization efficiencies (RIE). This work describes a systematic investigation of particles of ammonium nitrate, ammonium sulfate or levoglucosan associated with rBC (Cab-o-Jet) generated by atomizing aqueous solutions. Ratios of refractory:NR content by solution mass varied from 1:9 to 9:1, and the resulting aerosol were size selected to 300nm with a DMA. The presence of internally mixed particles was confirmed with a Single Particle Soot Photometer (SP2). Particle bounce at the tungsten vaporizer was assessed with a quadrupole (Q-) AMS equipped with a light scattering module. The SP-AMS switched between laser on and laser off modes, and also collected particle time of flight (PToF) and beam width probe (BWP) measurements to analyze aerosol compactness. As expected, the CE for the tungsten varies strongly with rBC fraction due to increasing bounce for particles with more rBC. CE at the laser vaporizer also decreases with increasing rBC due to particle beam focusing, but not as strongly. The interplay of these two CEs causes an apparent increase in NR-PM signal when the laser is on.

1IM.2

Evaluation of Uncertainties and Introduction of Tools for Quantification of Bulk Particle-phase Organic Nitrates Using Real-time Aerosol Mass Spectrometry. DOUGLAS A. DAY, Benjamin A. Nault, Pedro Campuzano-Jost, Jose-Luis Jimenez, *CIRES, University of Colorado, Boulder*

Organic nitrates and particle-phase organic nitrates ($pRONO_2$) play important roles in tropospheric chemistry, including radical budgets, ozone formation, SOA formation, and the reactive oxidized nitrogen budget. Over the last decade, the Aerodyne aerosol mass spectrometer (AMS), widely-used for measuring online aerosol composition, has been increasingly applied to quantify $pRONO_2$. An approach that relies on relative intensities of NO^+ and NO_2^+ ions in AMS spectra (“NO_x^+ ion ratio method”), when using a standard vaporizer, is the most common method applied, and was recently supported by demonstration of a reliable way to estimate $pRONO_2$ NO_x^+ ion ratios for complex ambient aerosol, the so-called “Ratio-of-Ratios” (*RoR*) method. However, little attention has focused on quantifying uncertainties for these methods. Therefore, we have systematically explored uncertainties associated with quantifying $pRONO_2$ (and NH_4NO_3) with the *RoR* method. Identified uncertainties are derived, quantified, and propagated to estimate overall uncertainty, relative importance of terms, and how they vary with averaging and aerosol composition. The analysis is extended to estimation of detection limits and unit mass resolution data. Overall uncertainties have substantial contributions from the ambient NO_x^+ ratio measurement, precision of NH_4NO_3 NO_x^+ ratio determination, *RoR* estimate of the $pRONO_2$ NO_x^+ ratio, and accuracy of the AMS total nitrate concentrations. Effects on quantification from matrix and instrument memory effects are evaluated using laboratory-generated mixtures of nitrates with inorganic and organic aerosol as well as complex ambient mixtures. We conclude that such effects, if present in ambient aerosol, are likely small. We have developed a publicly-available, open-source software for calculation of concentrations, uncertainties, and detection limits for $pRONO_2$ and NH_4NO_3. Finally, thermal denuder measurements for several field datasets were used to explore the efficacy of the *RoR* method and quantify volatility of $pRONO_2$, which was similar to less-oxidized, oxidized organic aerosol PMF factors.

1IM.3

Role of Relative Humidity in Controlling Ion Yields in Droplet Assisted Ionization. JOSHUA HARRISON, Kelvin Risby, Thomas Hilditch, Jim Walker, Bryan R. Bzdek, *University of Bristol*

Droplet assisted ionisation (DAI) is a voltage-free approach to create molecular ions from microscopic liquid droplets by passing them through a temperature-controlled capillary interface into a mass spectrometer. This approach is highly versatile, enabling sensitive detection of analytes in aqueous nanodroplets while avoiding artifacts from offline measurements. However, the ionization mechanism is not fully understood. The presence of a protic solvent like water is essential to the ionization process, but the effect of solvent has not been systematically explored. Here, the role of solvent on ion yield is explored by sampling plumes of submicron aerosol generated by atomizing aqueous solutions into the customized inlet of a SYNAPT XS time-of-flight mass spectrometer. The droplet water content was controlled by changing the relative humidity (RH) around the aerosol either with a Nafion dryer (to dry liquid droplets) or a water boat (to humidify dry particles). Aerosol number and mass concentrations were measured using a scanning mobility particle sizer. Ion yields were quantified from the ion count and sampled aerosol mass. Different analytes exhibited different RH-dependent ion yields that were consistent with each analyte’s hygroscopic response. For example, the ion yield for cortisol, a non-hygroscopic compound, showed no dependence on RH, whereas that for angiotensin II, a mildly hygroscopic peptide compound, displayed a clear increase (~2 orders of magnitude) at high RH compared to dry conditions. Finally, the ion yield for ammonium sulphate, a very hygroscopic inorganic compound, showed a strong dependence (~3 orders of magnitude) across a wide RH range. Ion yields were correlated to particle phase (solid, liquid) and water content (adsorbed water or solution droplet). The results demonstrate the importance of a protic solvent to generate ions during the rapid breakup of liquid droplets. The application of this approach to explore accelerated chemical reactions will also be discussed.

1IM.4

In Situ Chemical Characterization of Nanoplastic Particles by Aerosol Mass Spectrometry. Michael Tawadrous, Xing Wang, Alex K.Y. Lee, ARTHUR W. H. CHAN, *University of Toronto*

Extensive use of plastic products has introduced a large amount of plastic pollutants in urban areas and even in remote environments. Nanoplastic particles, in particular, can remain airborne for weeks and transported across greater distances. Characterization of atmospheric nanoplastic particles has been limited. Sampling methods used for larger microplastic particles, such as deposition sampling, and characterization methods, such as spectroscopy, are not applicable to nanoplastic particles. Furthermore, offline sampling methods involve extensive sample preparation procedures which can alter physical and chemical properties of the particles.

In this work, we investigate the use of aerosol mass spectrometry (AMS) as an in situ technique to characterize nanoplastic particle size and composition. We generate plastic particles via three different techniques: thermal decomposition of PET plastic bottles, 3D printing (using PET, ABS, and PLA filaments) and mechanical abrasion. Particle size was characterized using a Scanning Mobility Particle Sizer (SMPS). Particles were also sampled into a time of flight aerosol mass spectrometer (ToF-AMS) and onto quartz filters for offline characterization using pyrolysis gas chromatography mass spectrometry (Py-GC/MS).

We found that the AMS produced real-time particle mass spectra that were very similar to those measured by Py-GC/MS analysis of particles collected on filters. The consistency between the two techniques demonstrate that AMS can provide similar information about polymeric content as Py-GC/MS, which is a widely used technique for plastic materials, but at a substantially lower detection limit and higher time resolution. On the other hand, the use chromatographic separation in Py-GC/MS provides more comprehensive evaluation of polymeric composition. For example, we were able to detect changes in ratios between monomers and dimers of PET using Py-GC/MS.

Since AMS is a commonly used technique for non-refractory components in atmospheric aerosol, optimizing the AMS for nanoplastic particle detection will help understand the sources, dynamics, mixing state and fate of nanoplastic particles in the atmosphere.

1IM.5

Direct Determination of Melting Temperatures for Individual, Sub-Micron Isoprene Epoxydiol-Derived Secondary Organic Aerosol Particles. KATHERINE KOLOZSVARI, Cara Waters, Alison Fankhauser, N. Cazimir Armstrong, Jin Yan, Madeline Cooke, Yao Xiao, Rebecca Parham, Zhenfa Zhang, Avram Gold, Jason Surratt, Andrew Ault, *University of Michigan*

The phase state of atmospheric aerosol particles – solid, semi-solid, or liquid – influences their ability to take up water and participate in heterogeneous chemical reactions. Changes in phase state have been predicted by glass transition temperature (T_g) and viscosity; however, direct measurements of these properties is challenging for sub-micron particles. Historically, bulk measurements have been used, but this does not account for particle-to-particle variation or the impacts of particle size. Melting temperature (T_m) is the most significant predictor of T_g, and the two properties can be related through the Boyer-Beaman rule. Herein, we apply a recently developed method utilizing a nano-thermal analysis (nanoTA) module coupled to an atomic force microscope (AFM), to determine the T_m of individual secondary organic aerosol (SOA) particles generated from the reactive uptake of isoprene-derived epoxydiols (IEPOX) onto acidic ammonium sulfate aerosol particles. NanoTA works by using a specialized AFM probe which can be heated while in contact with a particle of interest. As the temperature increases, the probe deflection will first increase due to thermal expansion of the particle followed by a decrease at its T_m. The direct measurements are compared with model predictions based on molecular composition from hydrophilic interaction liquid chromatography coupled to electrospray ionization high-resolution quadrupole time-of-flight mass spectrometry (HILIC/ESI-HR-QTOF-MS) analysis. We compared the T_m of the SOA particles formed from IEPOX uptake onto acidic ammonium sulfate particles created at 30, 65, and 80% relative humidity (RH), and found that increasing RH from 30 to 80% led to an overall decrease in average T_m, indicating less viscous particles at higher RH conditions. Our measurements with this technique will allow for more accurate representations of the phase state of aerosols in the atmosphere.

1IM.6

Vapor Phase Transmission Electron Microscopy: Visualization Tool for In-Situ Aerosol Phenomena. DEWANSH RASTOGI, Yuhang Wang, Kotiba A. Malek, Akua Asa-Awuku, Taylor J. Woehl, *University of Maryland College Park*

Bulk particle measurements using aerosol instrumentation have been the backbone of cloud condensation studies and are used widely to understand the collective behavior of particles. Another emerging field of interest has been Single Particle Measurements (SPM); these measurements provide high-resolution data from individual particles under observation. SPMs are especially effective when coupled with bulk aerosol measurements by providing valuable insights about phase, morphology, and time-resolved data.

In this research, we build the groundwork for a visualization tool for in situ imaging of the process of water condensation on a Silicon Nitride (SiN) surface. In order to directly record the nanoscale condensation dynamics of sessile water droplets in electric fields, we use vapor-phase transmission electron microscopy (VPTEM). Sessile water nanodroplets were condensed by VPTEM imaging of saturated water vapor and grew to a size of about 500 nm before dissipating over the course of a minute. According to simulations, electron beam charging of the silicon nitride microfluidic channel windows produced electric fields of ~108V/m, which decreased the water vapor pressure and accelerated the nucleation of liquid water droplets of nanoscale. A mass balance model revealed that droplet evaporation was consistent with radiolysis-induced evaporation via the conversion of water to hydrogen gas, whereas droplet expansion was consistent with electric field-induced condensation. With the use of the model, we were able to quantify several electron beam-sample interactions and vapor transport characteristics, establish that electron beam heating was negligible, and show that the literature values considerably overestimated water vapor diffusivity and underestimated radiolytic hydrogen production. These experimental methods were refined to perform water condensation visualization on submicron salt particles (both organic and inorganic) under atmospheric conditions.

1IM.7

Volatility Measurements of Individual Components of Biomass Burning Organic Aerosol. QIAORONG XIE, Yun-Jung Hsu, Pooja Chaudhary, Diego Calderon-Arrieta, Emily Halpern, Christopher P. West, Katherine Hopstock, Sergey Nizkorodov, Chunlin Li, Yinon Rudich, Baerbel Sinha, Alexander Laskin, *Purdue University*

Biomass burning organic aerosols (BBOA) have profound effects on air quality, visibility, and radiative forcing of climate. Quantitative assessment of gas−particle partitioning of BBOA components is critical to understand their formation, growth, distribution, and evolution in the atmosphere. Here, we apply a novel method of temperature programmed desorption – direct analysis in real time – high resolution mass spectrometry (TPD-DART-HRMS) to measure the volatility distribution and variation of individual components in fresh and aged biomass burning BBOA. The BBOA produced by the burning of various solid fuels were sampled at test laboratory and filed studies. Then, they were exposed to photolysis by simulated sunlight. The apparent enthalpies of sublimation and saturation vapor pressure as a function of temperature of individual components in complex BBOA are obtained from acquired TPD-DART-HRMS records. The volatility distribution of organic components of BBOA specific to the burning of various biofuels is therefore investigated. Comparison of the saturation vapor pressure of individual components between fresh and aged BBOA describes their volatility variations, informing predictive understanding of BBOA ageing evolution. Our research demonstrates a new analytical method for volatility measurement of individual components in BBOA, which would have important implications for atmospheric modeling.

1SS.1

Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT): Advanced, Ground-based Aerosol Measurement Network Across the U.S. NGA LEE NG, Ann Dillner, Roya Bahreini, Armistead G. Russell, Alison Fankhauser, Richard Flagan, James Flynn, Drew Gentner, Robert Griffin, Lelia Hawkins, Jose-Luis Jimenez, Jingqiu Mao, Shane Murphy, Albert Presto, Sean Raffuse, Allen Robinson, John Seinfeld, Jason Surratt, Joel A. Thornton, Shan Zhou, *Georgia Institute of Technology*

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 strategically distributed across the continental U.S. and Alaska with urban, rural, and remote sites, including sites on tribal land, leveraging existing monitoring locations and facilities. The 12 sites encompass a wide range of geographical and climatic regions with variations in aerosol sources, characteristics, and atmospheric processing. A suite of advanced aerosol instrumentation for real-time measurements of fine aerosol chemical composition and properties has been installed at each site, including an Aerosol Chemical Speciation Monitor (ACSM, non-refractory aerosols), an Xact (trace metals), an Aethalometer (aerosol light absorption, black and brown carbon), and a Scanning Mobility Particle Sizer (SMPS, aerosol number size distribution and concentration). Standard operating procedures (SOP) for instrument installation, calibration, and general maintenance have been developed for each instrument. A comprehensive data infrastructure is also being developed. The data from each instrument are imported into a local site database and the import process features automated QC checks for basic level data. As all ASCENT sites become fully operational in late spring / early summer, we will share best practices, provide update on the status of the network, and present preliminary data from selected sites with diverse aerosol sources and processing. We also welcome collaborative opportunities leveraging the ASCENT infrastructure to advance our understanding of aerosol sources and characteristics on spatiotemporal scales not previously possible and enable new research capabilities in air quality, climate, and health.

1SS.2

Advancing Aerosol Research with the Next Generation Multiscale Infrastructure for Chemistry and Aerosols (MUSICA) and High-resolution Measurement Networks. ALMA HODZIC, Wenfu Tang, Duseong Jo, Roya Bahreini, Mary Barth, Matthew Dawson, Ann Dillner, Nga Lee Ng, Armistead G. Russell, Simone Tilmes, *National Center for Atmospheric Research*

The spatial distribution and properties of atmospheric aerosols are among the key sources of uncertainties in our understanding of air pollution effects on human health and climate. Here, we present an overview of next generation modeling and observational infrastructures designed to enhance research on atmospheric aerosol chemistry and composition over the contiguous US. The Multiscale Infrastructure for Chemistry and Aerosols (MUSICA), which is currently being developed at NCAR, is a cutting-edge community global atmospheric model that integrates aerosol chemistry and processes from local to global scales. MUSICA's initial configuration is based on the Community Earth System Model using the Community Atmosphere Model coupled with tropospheric and stratospheric chemistry, with a spectral element dynamical core featuring a grid mesh that can be regionally refined. This presentation will illustrate that MUSICAv0, with a 14-km CONUS regional refinement, shows similar spatial and temporal variability of aerosol pollutants and precursors to that of WRF-Chem near real-time predictions of air quality over CONUS. MUSICA more accurately represents influences from outside the CONUS region and the stratosphere, which are important for including the influence of large-scale fires, regional background, or slower removal processes. The Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT) is a new comprehensive, high-time-resolution measurement network in the U.S. for the characterization of aerosol chemical composition and physical properties. These measurements will provide a unique dataset to evaluate and refine the representation of aerosols in MUSICA. We will also discuss how an explicit chemistry mechanism generator can be used to bridge the gap between grid-scale concentrations from MUSICA and the point measurements from ASCENT.

1SS.3

Continental-Scale Biosphere - Atmosphere Interactions in Boreal Environment. TUUKKA PETÄJÄ, Ekaterina Ezhova, Meri Räty, Dmitri Moisseev, Veli-Matti Kerminen, Jaana Bäck, Harri Kokkola, Tero Mielonen, Taina Yli-Juuti, Annele Virtanen, Markku Kulmala, *University of Helsinki*

The boreal forest provides an ideal locale to study biosphere-atmosphere interactions, aerosol and cloud microphysical processes in a biogenically dominated environment. In this work, we will summarise recent work done at Station for Measuring Ecosystem – Atmosphere Relations, SMEAR II site in Southern Finland. We particularly focus on observational evidence on biosphere-atmosphere interactions and aerosol-cloud-precipitation interactions.

Our results show that the biospheric emissions of volatile organic compounds and their atmospheric processing first to condensable vapors and then to new aerosol particles is a relevant feature contributing to the properties of clouds and likely also to spatial variability of precipitation on a continental scale. It is crucial to maintain the comprehensive observational capacity (in-situ, ground-based and satellite-borne remote sensing) in order to better understand the feedbacks and interactions on a continental scale. Overall, the combination is critical in assessing the impact of climate change to the emissions, aerosols and clouds.

1SS.4

SOA Mass Formed via Multiphase Reactions of Hydrocarbons over the United States using CAMx-UNIPAR. YUJIN JO, Myoseon Jang, Azad Madhu, Jiwon Choi, Sanghee Han, *University of Florida*

Secondary Organic Aerosol (SOA) contributes a significant portion of atmospheric organic aerosol. Therefore, the prediction of SOA budget in regional/global scales is important to correctly evaluate its impact on health and climate forcing. However, it is challenging to accurately predict SOA formation due to its complexity in oxidation paths of hydrocarbons (HCs) and reaction mechanisms. In this study, the SOA mass was predicted by the UNIfied Partitioning Aerosol Reaction (UNIPAR) model that can simulate multiphase reactions of various HCs. The model utilizes lumping species originating from semi-explicitly predicted gas products using emerging atmospheric oxidation mechanisms of a wide range of anthropogenic HCs (10 aromatics and linear/branched alkanes in different carbon-lengths) and biogenic HCs (isoprene, terpene, and sesquiterpene) with three oxidation paths (ozone, OH radicals, and nitrate radicals) to predict day and night SOA formation. Resulting lumping species are involved in their multiphase partitioning and heterogeneous chemistry to form nonvolatile oligomers in both organic and inorganic aqueous phases. UNIPAR is incorporated with the Comprehensive Air quality Model with extensions (CAMx) to process SOA formation in regional scales. CAMx-UNIPAR is applied to predict SOA mass in the southern U.S., where isoprene is abundant, between February and April in 2021. Our exploratory simulation suggests that SOA mass produced in the southern U.S. is dominated by alkane and terpene owing to the contribution of autoxidation of alkane in daytime and nighttime oxidations of terpene with nitrate radical and ozone. Seasonal variations of isoprene SOA are also simulated by capturing the isoprene emission and aqueous phase reactions of isoprene products that are influenced by humidity. Spatial distributions of anthropogenic SOA associated with aromatic and alkane can be affected by wind directions owing to the relatively long lifetime of their atmospheric oxidation, whereas those of biogenic SOA were nearly insensitive to wind directions.

1SS.5

When Smoke Goes Up, PM Goes Down: Biomass Burning Plume Injection Height Effects on Observation Agreement, Surface PM2.5, and Radiative Forcing. NICOLE JUNE, Jeffrey R. Pierce, *Colorado State University*

Aerosols emitted from biomass burning have important effects on human health and climate both regionally and globally. These impacts may be altered by the plume injection height: a higher plume injection height (PIH) may increase lifetime of the smoke and decrease surface concentrations near the source. We use the global chemical transport model, GEOS-Chem-TOMAS, to examine the impacts of biomass burning plume injection height. We run four different PIH scenarios where all smoke is well-mixed into the boundary layer or smoke is injected following one of three plume injection height scenarios based off of heights in the GFAS emissions inventory. In comparison to observations, we find minor changes in agreement with AERONET and CALIPSO full-column AOD between the different PIH scenarios. In simulations where smoke is allowed to be injected above the boundary layer, there are improvements in agreement with CALIPSO extinction coefficient profiles, particularly in boreal regions. Globally, there is a decrease in surface $PM_{2.5}$ with the strongest decreases in biomass burning source regions with increasing PIH, and there is also a decrease in the number of days annually where the majority of surface $PM_{2.5}$ at a given location is due to smoke. Due to the increase in lifetime of the biomass burning aerosols with increasing PIHs, there is an increase in the tropospheric mass burden due to biomass burning, which increases the cooling seen in the clear-sky direct radiative effect. However, due to increases in smoke above clouds, the all-sky direct radiative effect has slightly less cooling with increasing PIH. The aerosol indirect effect shows more cooling with increasing PIH with the largest changes in marine stratocumulus regions.

1SS.6

Understanding New Particle Formation and Growth during the HI-SCALE 2016 Field Campaign over the Southern Great Plains (SGP) Region. MANISHKUMAR SHRIVASTAVA, Jie Zhang, Rahul Zaveri, Bin Zhao, Alla Zelenyuk, John Shilling, Jerome Fast, Brian Gaudet, Jeffrey R. Pierce, Havala Pye, Benjamin Murphy, *Pacific Northwest National Laboratory*

New particle formation (NPF) and growth govern cloud condensation nuclei (CCN) in many regions. The mechanisms governing the nucleation of molecular clusters vary substantially in different regions of the atmosphere. Additionally, the growth of these clusters to CCN sizes is often governed by the availability of extremely low volatility organic vapors (ELVOCs) formed by oxidation of volatile organic gases (VOCs) emitted from natural biogenic and anthropogenic sources. While the pathways to ELVOC formation from the oxidation of biogenic monoterpenes with ozone is better understood, the chemical and mechanistic pathways for ELVOC formation from oxidation of anthropogenic organics are not well understood. We integrate measurements and three-dimensional regional model simulations with the Weather Research and Forecasting Model coupled to chemistry (WRF-Chem) to understand the processes governing new particle formation and growth and SOA formation during the HI-SCALE field campaign at the Southern Great Plains observatory in Oklahoma, USA. Among our 8 different nucleation mechanisms that include organic- and inorganic- neutral and ion induced processes, we find that the amine+H2SO4 is the major nucleation mechanism near the surface. Through various WRF-Chem sensitivity simulations, we find that anthropogenic ELVOCs are critical for explaining the observed number size distribution of particles near the surface at the SGP site during the daytime. Our simulations show that volatile chemical products (VCPs) and mobile sources substantially contribute to anthropogenic secondary organic aerosols (SOA) over the SGP region, and their aging to ELVOCs is critical for explaining particle size distributions. On different days variations in the contributions of anthropogenic, biogenic, biomass burning SOA to particle growth is manifested in the particle size distributions and chemical composition observed by ground-based and aircraft measurements with the DOE G-1 aircraft during HI-SCALE.

1SS.7

Submicron Aerosol Spatial Variation in the Kathmandu Valley, Nepal 2018. BENJAMIN WERDEN, Michael R. Giordano, Khadak Mahata, Douglas Goetz, Md. Robiul Islam, Siva Praveen Puppala, Arnico Panday, Robert J. Yokelson, Elizabeth Stone, Peter F. DeCarlo, *Aerodyne Research, Inc.*

The rapidly developing urban Kathmandu Valley, Nepal, is subject to poor air quality from a variety of local and regional sources. The Nepal Ambient Monitoring and Source Testing Experiment [NAMaSTE] quantified emissions for a suite of common anthropogenic South Asian pollution sources and measured ambient aerosol composition and concentration.

Ambient aerosol mass spectrometer (AMS) measurements in pre-monsoon 2015 were taken in suburban Bode at the location of the previous SUSKAT experiment, and in Winter 2018 at three locations, an urban site, a suburban site, and a rural site on the valley rim. Mobile AMS measurements in pre-monsoon 2018 reinforce the spatial variation of aerosol composition and concentration due to source proximity.

PM_1 at the 2018 urban monitoring site, Ratnapark (mean 102 $\mu g/m^3$), was dominated by traffic emissions. The rural site, Dhulikhel (mean 48 $\mu g/m^3$), served as a regional background site, with minimal local sources; oxidized organic was the major aerosol fraction. The suburban sites, Bode Thimi (mean 40 $\mu g/m^3$) 2015 and Lalitpur (mean 106 $\mu g/m^3$) 2018, had seasonal differences, but significant impact from brick kiln emissions. Suburban sulfate concentrations peaked over 16 $\mu g/m^3$. Mean PM_1 exposure was above the 24-hour WHO threshold of 25 $\mu g/m^3$ and the annual limit of 10 $\mu g/m^3$ at all sites.

The average ambient PM_1 in urban Kathmandu during April 2018 was 34 $\mu g/m^3$; the rural background was 29 $\mu g/m^3$. Mobile measurements of on-road PM_1 averaged 65 $\mu g/m^3$. On-road PM_1 was at least 20% higher than ambient.

Sulfates exhibited regional scale influence with an enhancement of 20 $\mu g/m^3$ in industrial regions. Brick kiln plumes had sulfate concentrations up to 50 $\mu g/m^3$.

Ambient and mobile measurements combined quantify the contribution and spatial impact of localized sources of anthropogenic emissions and highlight the influence of source proximity.

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1UA.1

Wintertime Aerosol Volatility Measurements in Seoul, Korea Using a Thermodenuder (TD) Coupled with a High-Resolution Aerosol Mass Spectrometer (HR-ToF-AMS). HWAJIN KIM, Hyun-Gu Kang, Jiwoo Jeong, *Seoul National University*

Here the sources and volatility properties of ambient OA in Seoul during winter time were investigated by using a thermodenuder (TD) coupled with an high-resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS). The mean submicron aerosol (PM1 = NR-PM1 + black carbon(BC)) concentrations were 26.37µg/m3, varying between 4.61 and 91.4µg/m3 dominated by organics (41%) and nitrate (30%). The concentrations and chemical composition of PM1 varied considerably depending on meteorological conditions, atmospheric processes, and influences from local and regional emission sources.
Application of positive matrix factorization (PMF) on HR data identified six distinct OA sources: Hydrocarbon-like OA (HOA; O/C = 0.13), cooking-related OA (COA; O/C 0.18), nitrogen-enriched OA (NOA; N/C = 0.22), biomass burning OA (BBOA; O/C = 0.25), low-oxidized oxygenated OA (LO-OOA; O/C =0.68), and more-oxidized OOA (MO-OOA; O/C = 1.15).

Moreover, a volatility basis set (VBS) of the OA was derived by applying a mass transfer model on the measured mass fraction remaining (MFR) varying the temperature from 30-200˚C. The volatility distributions varied considerably depending on different OA sources. HOA, COA, NOA and BBOA showed overall high volatility. LO-OOA factor detected in the winter highly consisted of low volatility organic compounds (LVOCs, effective saturation concentration (C*) of 10-3 to 0.1µg/m3). MO-OOA, however, had an uncommon feature on the relationship between O/C ratio and the volatility. Details on these features will be discussed by comparing the other seasons and previous winter studies.

1UA.2

Chemical Composition of PM2.5 in Metropolitan Cities of India: Results from an Extensive Winter Campaign.

PRINCE VIJAY, Shreya Dubey, Nidhi Singh, Tamara Schikowski, Harish C Phuleria, *Indian Institute of Technology Bombay*

Ambient particulate matter concentrations in metropolitan cities in India and its peripheral towns has been a matter of serious concern for several decades. Understanding that the nature of the chemical composition of particulates changes, the spatial variability can be utilized for identifying probable sources. The study presents a dataset of the chemical composition of PM2.5 collected using MiniVol samplers, from 9 residential locations representing traffic-influenced, industrial-influence and residential zones during winter seasons in the year 2019–20. Identification of contributing sources using chemical ratios as source indicators was attempted. Daily PM2.5 concentrations were 131.3±71.8 for Mumbai, 75.2±33.4 for Bangalore and 192.2±75.5 µgm-3 for Delhi. The fine fraction was dominated by organic matter (OM) with mean concentrations of 45.9±33.6, 24.8±21.4, 60.8±25.8 for three cities respectively; followed by Elemental Carbon (EC) (11.2±3.3) for Mumbai, Sea Salt (SS) fraction (10.1±7.3) for Bangalore and Secondary Ions (SI) 18.56±4.05 µgm-3 for Delhi. Sulfate is the most abundant species among inorganic ions contributing ~40% in PM2.5 fraction. The average concentration of major and trace elements accounted for ~1.5% of PM2.5 mass. The air mass trajectories calculated by HYSPLIT model indicated that the air mass approaches to the observational site mainly from the neighbouring cities and even countries as in case of Delhi. The chemical ratios suggested mixed sources for fine fraction with major contributions from vehicular emissions, re-suspended and/or construction dust, and fossil fuel combustion along with intermittent contributions from biomass and open waste burning. The further analysis to quantitatively estimate source contributions to PM2.5 in urban environments provides useful insights to establish strategies to control anthropogenic air pollution. Further analysis is underway.

1UA.3

Primary Organics Drive Poor Wintertime Air Quality in Los Angeles.

RYAN X. WARD, Haroula D. Baliaka, Benjamin Schulze, Richard Flagan, John Seinfeld, *California Institute of Technology*

The Los Angeles basin is well known for its historically poor air quality, and despite strengthening of regulations, declines in particulate matter (PM) concentrations have stagnated over the last decade. Comprehensive, multi-institutional surveys of air quality in Los Angeles (e.g. CalNex) have been most frequently performed in the summer (nominally when routine air quality measurements of PM are highest) and have revealed that much of the aerosol pollution is driven by oxygenated SOA. In this work, we deploy a suite of aerosol- and gas-phase instruments to characterize the wintertime atmosphere between January and March in Pasadena, CA, including a ToF-ACSM with $PM_{2.5}$ inlet for aerosol composition. We observe PM loadings that are often comparable to summertime AMS measurements of organic aerosol, but with a diurnal cycle whose maximum appears in the evening as opposed to the afternoon. Positive matrix factorization of the mass spectral data demonstrates that, in contrast to summertime conditions, aerosol is predominately derived from primary (e.g., combustion and cooking-related emissions) rather than secondary sources. Further, we compare with routine air quality measurements of PM, CO, and NO_x, which largely suggests that boundary layer dynamics play a dominant role in the shifted diurnal profile, and additionally that this profile is a robust feature of the wintertime atmosphere in Los Angeles. Our results show that primary aerosol sources remain particularly relevant to LA air quality in the winter, underscoring the need to consider seasonality in the aerosol source distribution when developing policies to further reduce regional air pollution.

1UA.4

Measurement of Secondary Aerosol Formation in Ambient Urban Air Using Dual Portable Outdoor Chambers. XUANLIN DU, Alexander B. MacDonald, Ningjin Xu, Ying Zhou, Roya Bahreini, Don Collins, *University of California, Riverside*

Fine particulate matter (PM) causes serious effects on human health, air quality, and climate. Secondary aerosol (SA) is a major component of fine PM and is formed through chemical reactions involving precursor gases such as sulfur dioxide, nitrogen oxides, ammonia, and volatile organic compounds (VOCs). However, the formation, sources, and sensitivity of SA to different gas precursors need to be better understood. Most studies on the formation and properties of SA use traditional Teflon chambers in which one or more precursors are injected and UV lights are employed.

In this study, we present observations made using a complementary approach, for which a pair of 2-cubic meter portable chambers were operated with entirely or mostly ambient air under natural light conditions. We operated the Captive Aerosol Growth and Evolution (CAGE) chambers during three field studies, with the first two during spring and early fall 2022 in Riverside, CA, and the third during late winter 2023 in Wilmington, CA. We utilized two identical CAGE chambers to measure the sensitivity of SA concentration and composition to addition of different precursor gases. Monodisperse seed particles were injected intermittently into both chambers. We added a fixed concentration of NO2, VOCs, or NH3 into one of the chambers, while the other served as a reference chamber in which the gas composition mirrored ambient air just outside. The composition and volume concentration of the secondary aerosol formed in the chambers were quantified using an aerosol mass spectrometer (AMS) and a scanning mobility particle sizer (SMPS), respectively. We observed mass concentration enhancements and more frequent nucleation and growth of particles in the perturbation chamber after introducing VOCs and NH3 relative to the reference chamber. Together with simultaneously measured trace gas concentrations, the measurements of secondary aerosol in the chambers were used to investigate the responsible species and mechanisms.

1UA.5

Urban New Particle Formation in Houston. LEE TISZENKEL, James Flynn, Shanhu Lee, *University of Alabama Huntsville*

Urban new particle formation (NFP) is one of the main sources of ultrafine particles in highly populated and polluted regions worldwide. Urban NPF also contributes more significantly to the production of cloud condensation nuclei than in less polluted regions. Yet, the urban NPF processes are still poorly understood, mostly because of the lack of detailed chemical analysis of NPF precursors. We have conducted comprehensive measurements of sulfuric acid, ammonia, amines, and a large variety of OOMs (oxygenated organic molecules) produced from anthropogenic and biogenic volatile organic compounds, along with aerosol size distributions including newly nucleated sub-3 nm particles in Houston, Texas in September and October 2022. These chemical analysis helps us to better understand how aerosol nucleation and growth processes are controlled by different chemical species and how these processes are compared with those at other urban sites (e.g., Beijing, Shanghai, and Barcelona).

1UA.6

Changes of Submicron Particulate Matter in Summer Atlanta - Measurement Results by Aerosol Mass Spectrometer from Six Field Campaigns in the Last Decade. YUTONG LIANG, Jean Rivera-Rios, Tianchang Xu, Masayuki Takeuchi, Taekyu Joo, Lu Xu, Nara Shin, Sabrina Westgate, David Pando, Azin Eftekhari, Na Rae Choi, Seongbin Jo, Anna Kaehr, Yuyang Peng, Nidhi Desai, Aryiana Moore, Jennifer Kaiser, Nga Lee Ng, *Georgia Institute of Technology*

The concentration of submicron particulate matter (PM_1) in summer Atlanta has been declining over the last decade. Organic aerosol (OA), the main component of PM_1 in Atlanta, mainly comes from the oxidation of biogenic emissions. OA in summer Atlanta also shows a declining trend, though the biogenic emissions are not expected to substantially change. The reduction in OA is expected to be related to the reduction of sulfur dioxide and nitrogen oxides from anthropogenic sources, which are crucial in biogenic secondary organic aerosol (SOA) formation. However, to what extent the change in PM_1 is driven by the change in biogenic SOA remains unclear.

In this study, we focus on measurements of submicron non-refractory PM (NR-PM_1) by High-Resolution Time-of-Flight Aerosol Mass Spectrometer (HR-ToF-AMS) in six field campaigns in summer Atlanta (from 2012-2022) to determine which aerosol components are responsible for the decrease of NR-PM_1. We determined the sources of OA using positive matrix factorization (PMF) and identified five subtypes of OA. We found that the reductions of sulfate and isoprene-SOA dominate the reduction of NR-PM_1. The concurrent reduction of isoprene-SOA and sulfate is consistent with the role of sulfate in the formation of isoprene-SOA. We also decoupled the meteorological effects from the long-term trend caused by emission reduction using a machine learning model. Modeling results suggest that the long-term trend is the main factor explaining the variation of NR-PM_1 and its components in the decadal dataset, and the reductions of sulfate and isoprene-SOA also dominate the decrease of de-weathered NR-PM1. However, the reduction rate of deweathered OA (0.3 $\mu g\ m^{-3}\ year^{-1}$) is smaller than the reduction of observed OA (0.4 $\mu g\ m^{-3}\ year^{-1}$), indicating that weather should be considered when assessing the effect of emission changes on air pollution.

1UA.7

Increasing Contributions of Temperature-Dependent Oxygenated Organic Aerosol to Summertime Particulate Matter in New York City. TORI HASS-MITCHELL, Mitchell Rogers, Taekyu Joo, Benjamin A. Nault, Catelynn Soong, Mia Tran, Minguk Seo, Jo Machesky, Manjula Canagaratna, Joseph Roscioli, Nga Lee Ng, Ann Dillner, Roya Bahreini, Armistead G. Russell, Jordan Krechmer, Andrew Lambe, Drew Gentner, *Yale University*

As part of the summer 2022 NYC-METS (New York City metropolitan Measurements of Emissions and TransformationS) campaign and the ASCENT (Atmospheric Science and Chemistry mEasurement NeTwork) observational network, ambient concentrations of organic, nitrate, sulfate, ammonium, chloride, and black carbon particulate matter (PM) were measured in Manhattan and Queens, NYC, along with a range of supporting gas-phase measurements. Due to steady reductions in inorganic aerosol concentrations during the 21st century, summertime aerosol composition in NYC was predominantly organic (79-81%). Positive matrix factorization (PMF) source apportionment analysis shows major contributions from oxygenated organic aerosol (OOA) (73-76%), which is typically associated with secondary OA (SOA). The concentration and oxidation level of OOA source factors increased as a function of ambient temperature, including during a heatwave event in the measurement intensive period. The average ratio of total OOA to sulfate (5.8) was 4.5 times higher than previous observations. Additional primary source factors include hydrocarbon-like and cooking-related organic aerosols, which are comparatively less influenced by temperature and represent 10% and 14% of OA, respectively. The limited reductions in OA concentrations over recent years and the temperature-sensitivity of OOA source factors highlights the importance of a changing climate on summertime air quality in NYC given the established health impacts of SOA. Elevated temperatures, as well as extreme heat events, are likely to play an increasingly significant role in both the magnitude and composition of PM in NYC and similar east coast cities in the future. Therefore, greater attention to temperature-sensitive sources, emissions pathways, and associated chemical processing is required to make continued reductions in summertime PM in NYC and downwind areas.

2AC.1

Photoenhanced Radical Formation from Secondary Organic Aerosols and Surrogate Mixtures Derived from Biomass Burning Organic Aerosol Components. LENA GERRITZ, Meredith Schervish, Pascale Lakey, Tim Oeij, Jinlai Wei, Sergey Nizkorodov, Manabu Shiraiwa, *University of California, Irvine*

The photochemical aging of biomass burning organic aerosol (BBOA) by exposure to sunlight changes the chemical composition over its atmospheric lifetime, affecting toxicological and climate-relevant properties of BBOA particles. This study applies electron paramagnetic resonance (EPR) spectroscopy with a spin trapping agent BMPO, high resolution mass spectrometry (HRMS), and kinetic modeling to study photosensitized formation of reactive oxygen species (ROS) and free radicals in model BBOA. In mixtures of benzoquinone and levoglucosan, known BBOA tracer molecules, EPR analysis revealed substantial formation of hydroxyl radicals (•OH), hydrogen radicals (H•), and both carbon- and oxygen-centered organic radicals, which were generated by benzoquinone photochemistry, decomposition of semiquinone radicals, and •OH oxidation of levoglucosan, respectively. HRMS analysis confirmed the presence of free radicals derived from both benzoquinone and levoglucosan. Kinetic modeling of the processes in the irradiated mixtures successfully reproduced the time evolution of the observed formation of the BMPO adducts of •OH and H• observed with EPR. We used the same approach to investigate ROS formation from the irradiation of secondary organic aerosols from BBOA relevant molecules, phenol , α-pinene, α-terpineol, and toluene. We found substantial enhancements of radical formation most likely due to decomposition of labile organic hydroperoxides, as we observed their reduction of peroxide contents based on the iodometric–spectrophotometric method. These results imply that photoirradiation of aerosols containing photosensitizers induces ROS formation and secondary radical chemistry to drive photochemical aging of BBOA in the atmosphere.

2AC.2

Light Exposure of Wood Smoke Aerosols: Link between Chemical Composition and Optical Properties. CAROLYN LIU-KANG, Anna Sokolova, Jonathan Abbatt, *University of Toronto*

Increasing wildfire activity due to changing climate conditions has led to enhanced emissions of both gas-phase and particulate compounds from this source. Brown carbon (BrC) is a type of aerosol primarily emitted from biomass burning that has been shown to impact overall climate by its ability to absorb light in the ultraviolet and visible regions of the spectrum, potentially contributing to warming effects. However, due to its chemical complexity, as well as the range of atmospheric aging mechanisms affecting its composition and absorption properties, its effect on regional climate remains uncertain. Placing our focus on individual aging processes aids in understanding the overall picture of BrC aging during its time in the atmosphere.

Here, we investigated the effects of UV light exposure on the absorption capacity and chemical composition of BrC aerosols and the concomitant role played by other reactants in this aging process, such as molecular oxygen. In-lab generation of wood smoke aerosols from pine wood was conducted, with aging by photoreaction in both the aqueous, in-cloud, phase and particle state. Oxygen was removed from the reaction system, and the products were characterized by UV-Vis for the optical properties, high resolution mass spectrometry for the chemical composition, and electron paramagnetic resonance for radical formation. Results indicate that molecular oxygen plays an important role, partially in the form of singlet oxygen.

2AC.3

The Sensitivity of Modeled Secondary Organic Aerosol (SOA) Formation to Differences in Speciation Profiles of Biomass Burning Derived Non-Methane Organic Gases (NMOGs).

SAMIHA BINTE SHAHID, William P. L. Carter, Robert J. Yokelson, Kelley Barsanti, *University of California, Riverside*

Biomass burning (BB) is a major contributor of non-methane organic gases (NMOGs) in the atmosphere. These highly reactive compounds can have significant impacts on tropospheric chemistry by influencing oxidant concentrations and formation of secondary pollutants, including secondary organic aerosol (SOA). Recent field and laboratory campaigns have made significant progress in measuring the emissions of ~1000s of NMOGs from BB. However, these measurements have not yet been fully integrated into models, which typically include representation of only a limited subset of measured NMOGs. To facilitate the use of recent BB emissions data in models, we developed the Next-generation Emissions InVentory expansion of Akagi (NEIVA). NEIVA is a comprehensive emission factor database that integrates data from laboratory- and field-based biomass burning studies that have been published since 2015 with data from the widely used Akagi et al. 2011 compilation. NEIVA provides detailed speciation of NMOGs emitted from BB grouped into 14 globally relevant fuel or fire types, and uses this information to generate NMOG profiles for gas-phase mechanisms including SAPRC, MOZART, and GEOS-Chem. This allows for the translation of chemically-detailed measurements into model-ready inputs. To evaluate the sensitivity of BB plume chemistry and composition to NMOG speciation, model simulations were performed using NEIVA and two other existing BB inventories as inputs, Andreae 2019 and EPA SPECIATE. Modeling was performed using the Lagrangian plume model case in F0AM, with an integrated thermodynamic equilibrium SOA model we developed based on the CMAQ AERO-07 aerosol module. The model outputs used for comparison included OH reactivity, gas-phase product mixing ratios, and SOA mass concentrations. The model simulations demonstrate the sensitivity of plume chemistry and composition to NMOG speciation and support the need to more adequately represent the diversity of NMOGs emitted from BB.

2AC.4

Impacts of Aging and Relative Humidity on Physical Properties of Wildfire Smoke.

Liora Mael, SOFIE SCHWINK, Thomas Dunnington, Nicholas Gotlib, Marina Vance, *University of Colorado Boulder*

Smoke inhalation can cause short- and long-term health effects, including respiratory irritation, shortness of breath, exacerbation of asthma, and chronic heart disease. The occurrence of wildfire events is increasing across the United States, making it vital that we understand how wildfire smoke impacts human health and how its properties evolve in indoor environments. Building on work done during the 2022 Chemical Assessment of Surfaces and Air (CASA) indoor chemistry field campaign, we performed controlled laboratory experiments measuring physical properties of smoke aerosols, including size distributions, aerosol liquid water content (ALWC), and aerosol effective density (ρ_{eff}). Size distributions were measured using a pair of scanning mobility particle sizers (SMPS), with and without a diffusion dryer. Particle mass was determined using an aerosol particle mass spectrometer (APM). Data from these instruments were combined to determine ALWC and ρ_{eff}. Fresh and aged (via ozone oxidation) experiments were conducted in a 0.68 m^3 stainless steel chamber with three relative humidity levels: low, medium, and high. These different environmental conditions led to changes in particle size distribution, effective density, and water uptake. Differences in these properties over time and in different ambient conditions could lead to changes in health effects of exposure to smoke as well as calibration factors for low-cost sensor applications, so it is important to understand and quantify physical changes of smoke over a range of conditions.

2AC.5

Understanding the Effect of NOx on the Secondary Organic Aerosol Formation from Phenolic Compounds from Biomass Burning.

DAVID PANDO, Magesh K. Mohan, Rodney J. Weber, Nga Lee Ng, *Georgia Institute of Technology*

As the world moves towards cleaner energy and the effects of global warming worsen, biomass burning has taken a larger fraction of the carbon emissions to the atmosphere and that fraction is expected to keep growing. Phenolic compounds account for a large portion of the volatile organic compounds (VOC) that are emitted to the atmosphere from biomass burning and their oxidation in the atmosphere can result in the formation of secondary organic aerosols (SOA). However, the processing of phenolic compounds and their oxidation products in the presence of NOx (which is emitted during biomass burning) is not well characterized. In this work, the effect of NOx on SOA formation from phenolic compounds is studied in the Georgia Tech Environmental Chamber (GTEC) facility. The VOC, other gases, and particles in the chamber are monitored by on-line instruments such as GC-FID, NOx monitor, ozone monitor, SMPS, FIGAERO-CIMS, and AMS. In our experiments we find that NOx enhances the SOA formation from phenolic compounds. For about 75 ppb of reacted phenol, the SOA yield (aerosol formed/VOC reacted) in high NOx experiments is approximately 55% to 60%, compared to the experiments conducted without NOx injection where the SOA yield is 24%. Further, formation of brown carbon is also increased in the presence of NOx. These results highlight the capacity of NOx to enhance SOA formation from phenolic compounds in biomass burning and open the door to further exploration.

2AC.6

Mass and Physical Property Changes of Organic Aerosol (OA) Induced by Photolytic Aging.

BIN BAI, Yuchen Wang, Nara Shin, Yaowei Li, Frank Keutsch, Nga Lee Ng, Pengfei Liu, *Georgia Institute of Technology*

Organic aerosols (OA) constitute a significant fraction of the atmospheric particulate mass. Previous studies have shown that solar radiation in UV wavelengths can directly break the chemical bonds of OA species. This process, defined as OA photolytic aging herein, has been reported as a potentially important chemical removal pathway that can largely shorten the OA lifetime and affect the particle mass loading. This process can also influence the oxidation state, volatility, viscosity, and optical properties of OA. However, the kinetics and underlying chemical processes of photolytic aging remain unclear. The relationships between the mass loss, which involves the formation of volatile organic vapors, and changes in the remaining particle-phase species have not been comprehensively studied. Here, we have simultaneously monitored the mass decay, volatility, and hygroscopicity change of lab-generated OA samples illuminated by UV light under atmospheric-relevant humidity using a high-sensitivity quartz crystal microbalance (QCM-D). We have observed a rapid mass decay accompanied by significant particle volatility and hygroscopicity change for limonene ozonolysis OA and isoprene photo-oxidation OA. A unified box model by lumping OA species based on decadal volatility has been developed to reproduce the measured changes in OA mass, volatility, and hygroscopicity during photolytic aging. These results could help mitigate the knowledge gap in understanding the atmospheric fate and burden of OA, and help evaluating their environmental effects.

2AC.7

Brown Carbon Formation by Aqueous Phase Reactions of Glycolaldehyde and Methylamine. Camille Carthy, Erin O'Leary, Swetha Tadisina, Daniel Griffith, Heidi Hendrickson, Joseph Woo, MELISSA GALLOWAY, *Lafayette College*

Brown carbon in aerosol remains a significant source of error in global climate modeling due to its complex nature and limited product characterization. Though significant efforts have been made in the previous decade to identify the major light absorbing brown carbon chromophores formed through the reactions of small difunctional carbonyl-containing compounds with ammonium, substantial work is still required to identify the main absorbing species resulting from reactions of carbonyls with more complex amines. Using tandem mass spectrometry and isotopic substitution experiments to confirm proposed structures and support their mechanistic pathways, evidence is provided for the formation of N-containing oligomers and heterocycles in glycolaldehyde + methylamine reaction systems. Reaction kinetics and surface tension measurements provide evidence for changing physical properties as a function of reaction progress. These products contribute to brown carbon light absorption, thus holding significant relevance toward accurately predicting their effects on global climate.

2AC.8

Evidence of Photoacidic Characteristics by Nitrophenols in Organic Matrices. AVERY DALTON, Dmitry Fishman, Sergey Nizkorodov, *University of California, Irvine*

The condensed phase photochemistry of nitrophenols has been the subject of much scientific inquiry, revealing ambient photodegradation lifetimes on the order of days to weeks depending on the matrix encapsulating the nitrophenol. Despite such investigations, the mechanisms through which these molecules degrade, particularly para-nitrophenols, are still largely ambiguous. Considering the relatively low volatility of these molecules it becomes important to have a detailed understanding of their photochemistry in the atmosphere. This work aims to investigate the ultrafast photochemical dynamics of 4-nitrocatechol (4NC), a strong chromophore which has been used in laboratory studies as a proxy for brown carbon. 4NC exhibits “push-pull” characteristics which could strengthen its potential to act as a photoacid. The effects of aqueous and organic solvents are examined and reveal implications toward environmental degradation of nitrophenols. Preliminary results indicate that 4NC may be capable of excited-state proton transfer on ultrafast timescales, even in a weakly-protic solvent 2-propanol. Though nitrophenols are often expected to react via excited triplet states, this work supports other recent findings that suggest more consideration should be put toward the role of the anions of these molecules in their overall photodegradation in cloud water and organic aerosol particles.

2AC.10

Kinetics in Colliding Microdroplets: Accelerated Synthesis of Azamonardine from Dopamine and Resorcinol. EMILY BROWN, Grazia Rovelli, Kevin R. Wilson, *Lawrence Berkeley National Laboratory*

Micron-sized compartments have become a recent focus of study as strong electric fields, pH effects, and surface confinement among other properties have been revealed to lead to unique reaction acceleration. Micron-sized compartments are ubiquitous in the environment including aerosols, rock pores, and biological compartments which makes understanding their chemistry a priority. The reaction of dopamine with resorcinol to form the fluorescent product azamonardine is used as a model system to examine how droplet interfaces accelerate reaction kinetics. This reaction is initiated in a branched quadrupole trap (BQT) by colliding two droplets and observing the formation of azamonardine. The BQT allows for observation of single droplets with control over droplet size, concentration, and charge. The reaction was observed to be accelerated in droplets from 9 to 35 micron in radius by as much as 7.4 times. Kinetic modeling suggests that the acceleration can be attributed to rapid diffusion of oxygen into the droplet and increased reagent concentrations at the air-water interface.

2AC.11

Determining the Controls on Buffering Capacity and pH Evolution of Inorganic Aqueous Droplets Using Aerosol Optical Tweezers. GRAHAM THORNHILL, Hallie Boyer Chelmo, Luke Monroe, Yucheng Zhang, Ryan Sullivan, *Carnegie Mellon University*

Aerosol physicochemical properties such as composition and morphology along with the multiphase chemical reactions that aerosols undergo are all directly affected by the acidity of each particle. The direct determination of aerosol pH, however, is challenging due to wide aerosol size distributions, tiny sample volumes, varying complex compositions, and the need to account for non-ideal thermodynamics in high solute concentration droplets. Given these challenges, the driving factors and sensitivities of changes in atmospheric aerosol pH and buffering capacity are not well understood. Recently our lab developed a method for directly determining aerosol pH via the cavity-enhanced Raman spectrum obtained continuously from single levitated droplets using aerosol optical tweezers. This method allows for continuous pH determination in inorganic sodium bisulfate droplets over a range of -0.36 to 0.76, with an accuracy of ±0.03-0.06 pH units. Here we present an expansion of this pH determination method to more complex inorganic droplets containing sulfates, nitrate, and ammonium in equilibrium with ammonia vapor. The buffering capacity and pH sensitivity to initial aerosol composition and the partial pressures of water vapor and ammonia were determined by varying the gas-phase concentrations in equilibrium with the tweezed droplet. The temperature of the tweezed droplet was also varied to determine its effect on the buffering capacity and pH. These experiments provide new insights into the controlling parameters of the evolution of the pH of inorganic aerosol droplets and its relationship to the surrounding gas-phase composition.

2AC.12

Kinetics of Hypochlorous Acid Reactions with Organic and Chloride-Containing Tropospheric Aerosol. SPIRO JORGA, Tengyu Liu, Yutong Wang, Sumaiya Hassan, Han N. Huynh, Jonathan Abbatt, *University of Toronto*

The Cl atom plays a crucial role in tropospheric oxidation processes, in both the marine and continental environments. Although modeling studies have explored the importance of halogen chemistry, uncertainty remains in associated chemical mechanisms and fundamental kinetics parameters. Prior kinetics measurements of multiphase halogen recycling reactions have been performed with dilute, bulk solutions, leaving unexplored conditions with more realistic chemical systems which have high solute concentrations and are internally mixed with both inorganic and organic components. Here, we address the multiphase kinetics of HOCl using an aerosol flow tube and aerosol mass spectrometer to study its reactions with particulate chloride, using atmospherically relevant particle acidity, solute concentrations, and ionic strength. We also investigate the chemistry that results when biomass burning aerosol components and chloride are internally mixed. Using pH-buffered particles, we show that the rate constant for reaction of HOCl with H^+ and Cl^- is within a factor of two of the literature value at high relative humidity (RH) (80-85%). However, at lower RH values (60-70%) where the particles become concentrated, the rate constant is an order of magnitude higher. For pure organic compounds commonly found in biomass burning (BB) aerosol, an increase in the aerosol chlorine concentration occurs with HOCl exposure, indicating the formation of organochlorine species. Together, these independent findings explain results for internally mixed aerosol particles with both chloride and BB components present where we observed results consistent with both chloride loss and organochlorine formation occurring simultaneously with HOCl exposure. Overall, we conclude that chlorine recycling via HOCl uptake will occur under a wide range of RH conditions and when reactive BB organic compounds are present in the same particles as chloride.

2AC.13

Light Absorption at Near-Infrared Wavelengths by Organosulfate Aerosols. AUGUST LI, Joshin Kumar, Joseph V. Puthussery, Nurun Nahar Lata, Gregory W. Vandergrift, Zezhen Cheng, Felipe Rivera-Adorno, Valerie Viteri, Benjamin Sumlin, Ganesh Chelluboyina, Alexander Laskin, Swarup China, Rajan K. Chakrabarty, *Washington University in St. Louis*

Organosulfate (OS) aerosols are an important contributor to the secondary organic aerosol mass burden over the continental United States. While OS chemical properties and formation pathways have been extensively studied, knowledge of their optical properties remains elusive. Here, we investigated the spectral optical properties of ambient OS particles at a coastal industrial site in La Porte, Texas, as part of the Department of Energy’s TRacking Aerosol Convection interactions ExpeRiment (TRACER) field campaign during July and August 2022.

Aerosol absorption and scattering coefficients were measured in real time using custom-built integrated photoacoustic nephelometer spectrometers, which operated at 405, 721, and 1047 nm. Synchronous filter sampling of particles was performed and subsequently analyzed for particle-resolved composition using computer-controlled scanning electron microscopy. Based on approximately 15,000 particles analyzed, we identified two distinct periods of OS loadings: one where OS comprised 28% of the total particles (“OS dominant”), and one where OS was largely a background contributor (12%; “OS background”).

The airmass corresponding to the OS dominant period originated from the Houston shipping channel and marine emissions. This period was characterized by an average absorption coefficient (B_{abs}) of 7.98 Mm^{-1} and single scattering albedo (SSA) of 0.71 at 405 nm. At 1047 nm, OS particles contributed to 36% of aerosol absorption, with the remaining fraction attributed to black carbon. The OS particles resisted morphological distortion when heated to 450 °C under atmospheric pressure, indicative of their low volatilities. By comparison, the OS background period showed a relatively lower B_{abs} of 6.41 Mm^{-1} and a higher SSA of 0.83 at 405 nm. During this period, the OS contribution to 1047-nm light absorption was 17%. Collectively, our results suggest that increasing OS abundance is associated with reductions in SSA due to higher absorption and lower scattering at near-UV wavelengths and enhancements in light absorption at near-IR wavelengths. OS aerosols could be significant contributors to shortwave forcing in regions dominated by shipping and chemical refinery emissions.

2AC.14

Assessing the Effects of Wet Deposition: Observing Removal Timescales for Gases and Aerosols in Semi-Urban and Remote Areas. CHRISTOS STAMATIS, Chenyang Bi, Gabriel Isaacman-VanWertz, *Virginia Tech*

A substantial fraction of secondary organic aerosol (SOA) is formed through the multigenerational oxidation of reactive organic gases. Therefore any processes such as wet and dry deposition that remove gases, in particular lightly oxidized and/or condensable gases, will affect the thermodynamic equilibrium and the formation of SOA. Unfortunately, there are few direct observational constraints on the wet deposition of oxygenated gases and particles and their timescales of removal, leading to significant uncertainty regarding the impact of precipitation on aerosols. In this work we will present observationally constrained estimates of wet deposition timescales for gases and particles. Precipitation size distribution data from globally distributed sites in the Department of Energy Atmospheric Radiation Measurement (ARM) network and in Blacksburg, VA provided highly detailed measurements of precipitation characteristics, collocated with measurements of wet scavenging of particle size distributions. We combine these data with measurements of oxygenated gases across a range of volatilities collected during precipitation events in Blacksburg, Virginia using a proton-transfer time-of-flight mass spectrometer (VOCUS PTR-TOF MS) and a semi-volatile thermal desorption aerosol gas chromatograph (SV-TAG). Direct observations of removal are combined with precipitation data to calculate scavenging coefficients that are size-dependent (for particles) and solubility-dependent (for gases). Studying the real-world measurements from these diverse geographical locations will lead to an improved understanding of wet deposition timescales for gases and how precipitation parameters such as precipitation duration, intensity and size distribution affects aerosol chemical properties and mass.

2AC.15

The Response of Summertime Organic Aerosol Composition to Emission Controls in the Northeastern United States. JIE ZHANG, Junfeng Wang, Yele Sun, Shan Zhou, ManishKumar Shrivastava, Alexandra Catena, Nga Lee Ng, Qi Zhang, James Schwab, *Atmospheric Sciences Research Center, University at Albany*

The responses of secondary organic aerosols (SOA) to emission controls remain uncertain due to the limited continuous long-term measurements. Measurements of detailed carbonaceous aerosol composition in the New York City metropolitan region during the summers of 2001, 2009, 2011, 2018 provide a look at the changes in summertime SOA over the past two decades when significant pollution reduction and emission controls occurred in the northeastern United States. Here, we show that the averaged nighttime SOA, especially the fresh local SOA, extreme mass concentrations resulted from anthropogenic volatile organic compounds (VOCs) reductions, while there is a little trend for the regional aged SOA. Meanwhile, these fresh SOA extremes occurred most often under conditions of high relative humidity during nighttime. The analysis presented here provides a comprehensive evaluation of the evolution of the increasingly important organic component of the submicron ambient aerosols in this major metropolitan area.

2AC.16

Sensitivity of PM2.5, and Nitrate Concentrations to NH3, HNO3, and SO42- Control in NH3-Rich Urban Areas: A Case Study of Seoul, South Korea. JOONHYEOK CHOI, Ji Yi Lee, Joonyoung Ahn, Mijung Song, *Jeonbuk National University*

Seoul, a megacity in East Asia, is currently grappling with significant air quality challenges caused by high levels of particulate matter (PM) pollution, specifically particulate NO_3^-. To improve air quality and reduce nitrate pollution, it is imperative to control the concentrations of either nitric acid (HNO_3) or ammonia (NH_3). In this study, we analyzed water-soluble inorganic ions (WSIIs) and gaseous species (HNO_3, NH_3, and SO_2) in Seoul from 2020 to 2022 to investigate how $PM_{2.5}$ and nitrate concentrations are affected by NH_3, HNO_3, and SO_4^{2-} control in the NH_3-rich region. We used the ISORROPIA-II thermodynamic equilibrium model to assess the sensitivity of aerosol pH, $PM_{2.5}$, and NO_3^- mass concentrations to NH_3, HNO_3, and SO_4^{2-} control. Our findings will be presented, and they can provide valuable insights for reducing $PM_{2.5}$ concentrations in NH_3-rich urban areas, informing policymakers and stakeholders to develop effective strategies for improving air quality.

2AC.17

Sources and Global Distribution of Atmospheric Perchlorate Aerosol. PEDRO CAMPUZANO-JOST, Dongwook Kim, Hongyu Guo, Benjamin A. Nault, Jason Schroder, Rainer Volkamer, Joseph Katich, Joshua P. Schwarz, Chelsea Thompson, Jeff Peischl, Thomas Ryerson, Andrew Weinheimer, Alessandro Franchin, Teresa Campos, Rebecca Hornbrook, Alan Hills, Eric Apel, Roisin Commane, Bruce Daube, Steven Wofsy, Glenn Diskin, Yuk Chun Chan, Lyatt Jaegle, Jose-Luis Jimenez, *CIRES, University of Colorado, Boulder*

Perchlorate (ClO_4^-) is ubiquitous in the environment. Ice core data suggest it has been steadily increasing globally since the 1970s. The health implications of this increase are controversial. But importantly, we also know very little about the sources and chemistry driving this increase. There are some natural deposits of perchlorate, and perchlorate is produced industrially for rocket propellants. However, as recently reviewed by Chan et al. (2023), most of the available evidence suggests that neither of these sources can explain the increase. Rather, the deposited perchlorate is likely formed by atmospheric oxidative chemistry.

We have recently shown that specific, quantitative detection of perchlorate in ambient submicron aerosol is possible using an Aerodyne HR-AMS instrument. Subsequent analyses have refined our understanding of the instrument's response in polluted environments and led to significantly enhanced detection limits (0.25 pptv / 1 ng m^{-3} @STP for 1 min sampling). This work leverages a reanalysis of a large set of NASA, NSF, and DOE campaigns to derive the first atmospheric dataset of perchlorate of near global scope up to altitudes of 14 km.

Perchlorate has been proposed previously as a byproduct of the stratospheric ClO_x cycle (Jaegle et al, 1996), which matches the strong stratospheric signature in our dataset (up to 3 pptv). GEOS-Chem simulations, with a simple modified ClO_x mechanism, are able to reproduce the stratospheric observations, but cannot account for the large tropospheric deposition.

Our dataset shows that significant amounts of perchlorate are detected downwind of large urban areas and open fires, with emission factors between 10-30 µmol/mol relative to CO, suggesting strong combustion sources of perchlorate. Implementing such sources in GEOS-Chem markedly improves overall model skill. Evidence for additional tropospheric sources of perchlorate, such as volcanic eruptions and boundary layer ozone depletion, and its implications will be discussed as well.

2AC.18

Seasonal Comparison of Particulate Matter Chemical Composition in Riverside, California. ALEXANDER B. MACDONALD, Xuanlin Du, Ningjin Xu, Ying Zhou, Cesunica E. Ivey, Don Collins, Roya Bahreini, *University of California, Riverside*

Elevated concentrations of fine particulate matter (PM) with diameter ≤ 2.5 µm ($PM_{2.5}$) pose a serious threat to human health, as $PM_{2.5}$ is linked to respiratory diseases and mortality. Even though vehicular emissions of polluting precursor gases have decreased in California thanks to regulations implemented in recent decades, underappreciated sources such as industrial operation emissions and volatile chemical products contribute significant precursor gases. Several regions across California still exceed 24-hour $PM_{2.5}$ National Ambient Air Quality Standards (NAAQS), with some regions being disproportionately more affected than others. This study is a comparison between two 4-week campaigns in late winter and summer 2022 in Riverside, California, a region which is influenced by fresh, local urban pollution sources and aged emissions from the greater Los Angeles Basin. Size-resolved chemical composition of the ambient PM was measured using an Aerodyne compact time-of-flight mini aerosol mass spectrometer (CToF mAMS). Results suggest that the photochemical production of secondary aerosol was greater during the summer campaign, as approximated by more pronounced changes in mass concentration with the diurnal cycle. Higher ratios of nitrate to organic during summer highlight the periodic importance of inorganic aerosol components in Riverside even during the summer months.

2AC.19

Interactions of Anthropogenic and Biogenic Pollutants: Overview of the Spruce 2022 Campaign. ANGELIKI MATRALI, Christina N. Vasilakopoulou, Kalliopi Florou, Andreas Aktypis, Agata Kołodziejczyk, Christos Kaltsonoudis, Evangelia Kostenidou, Kacper Błaziak, Dontavious Sippial, Spyros N. Pandis, *University of Patras, Greece*

The SPRUCE-22 field campaign was conducted during July 2022, on a remote mountainous forested site in Greece to quantify the interactions of biogenic and anthropogenic pollutants in the Eastern Mediterranean. Particle chemical composition and size distributions along with VOCs and other gases were measured at high temporal resolution using state-of-the-art instrumentation (AMS, PTR-MS, SP_2, etc.), while samples were collected and analyzed off-line (HP-LC, XRF, GC-MS, ^{14}C, oxidative potential, etc.). Dual smog chamber experiments were performed to investigate the chemical aging of the PM.

PM_1 had a surprisingly high average concentration of 12.7 µg m^{-3} consisting primarily of organics (57%), followed by sulfate (30%) ammonium (9%), and black carbon (2%). Nitrate levels (both inorganic and organic) were less than 1% of the fine PM despite the relatively high NO_x emissions in the Balkans. The $PM_{2.5}$ daily concentrations at this remote site were similar and even higher than those in major cities across Greece including Athens, indicating the importance of regional transport for summertime pollution in this area. The relatively constant average diurnal profiles of major anthropogenic pollutants (black carbon, NO_x, aromatic VOCs, etc.) are consistent with the lack of local sources. Sulfates were not any more the dominant component of fine PM due to the reduction of SO_2 emissions by coal-burning powerplants. The organic aerosol (OA) was quite oxidized with average oxygen to carbon ratio (O:C) equal to 0.83. The average isoprene concentration was 0.6 ppb, of the monoterpenes 0.5 ppb, and biogenic SOA was estimated to contribute 24% of the OA. The biogenic SOA was quite aged (O:C equal to 0.63) and the mobile dual smog chamber experiments suggested that additional aging was rather slow. Local nucleation events were scarce. The source attribution of the fine PM and the interactions among its anthropogenic and biogenic components are discussed.

2AC.20

Seasonal Variation in Molecular Composition of Organic Aerosol at the Southern Great Plains Observatory. GREGORY W. VANDERGRIFT, Sonja Moons, Nurun Nahar Lata, Zezhen Cheng, Darielle Dexheimer, Rahul Zaveri, Fan Mei, Swarup China, *Pacific Northwest National Laboratory*

Agricultural land accounts for approximately 52% of the United States land base alone, demonstrating the dominance and importance of this land type. This study aims to better understand the organic molecular composition of atmospheric particles influenced by agricultural land, informing the landscape impact on weather and climate. Specifically, 80 samples were collected from the Atmospheric Radiation Measurement's (ARM) Southern Great Plains (SGP) Observatory (agricultural region of Oklahoma, USA) during periods of day and night across different seasons spanning a period of two years (May, July, October 2021 and February, April 2022). Bulk aerosol was sampled directly from filter substrates via nanospray desorption electrospray ionization coupled with high resolution mass spectrometry (nano-DESI HRMS). Resultant mass spectra were subjected to molecular formulae (MF) assignment, resulting in over 3300 unique MF containing carbon, hydrogen, oxygen, nitrogen, and/or sulfur atoms. A total of 15 distinct intersections containing ≥50 MF between the five different seasons were identified, informing the seasonality of secondary organic aerosol (SOA) molecular composition above agricultural land. Particularly populous intersections included MF unique to April 2022 (483 MF, informing wildfire related SOA), MF unique to October 2022 (360 MF, showing increased aromaticity and oligomeric MF), MF unique to May 2021 (231 MF, dominated by organosulfates and correlated with southerly winds), and MF detected in all periods except February 2022 (254 MF, detailing SOA that is not observed in cold weather conditions). Current work involves leveraging additional datasets collected at the SGP site to better understand various atmospheric processes such as new particle formation (NPF). Combined with modelling and HRMS datasets, a molecular level understanding NPF and subsequent aerosol growth at the SGP observatory is being investigated.

2AC.21

Insights about the Sources of Organic Aerosol from Measurements of Organic Tracer Compounds in an Eastern Mediterranean Forested Site. Agata Kołodziejczyk, Kacper Błaziak, ANGELIKI MATRALI, Christina N. Vasilakopoulou, Ksakousti Skylakou, Spyros N. Pandis, *University of Patras, Greece*

Terpenoids are known important precursors of secondary organic aerosol (SOA) which constitutes a significant part of particulate matter worldwide. Filter samples and fir needles were collected from a forest in a Greek mountain site for a month in July 2022, where high modeled concentrations of these biogenic compounds are expected. Analysis of essential oils derived from the needles with GC-MS and GC-FID, indicated high levels of monoterpenes (78 - 83 %) and lower levels of sesquiterpenes (5 – 10%). The filters were analyzed for organic tracers with LC-ToF-MS. Sixteen acids of biogenic and anthropogenic origin were quantified with authentic standards representing a total average concentration of 46 ± 11.6 ng m^{-3}. The highest average concentrations were observed for cis-pinonic (6.2 ± 1.9 ng m^{-3}) and terebic acid (5.8 ± 2.8 ng m^{-3}). Additionally, 160 other organic compounds were quantified with the use of surrogate standards with average concentrations for the campaign duration of 1107 ± 154 ng m^{-3}. Amongst these approximately 20 compounds were classified as organosulfates or nitroxy organosulphates based on literature with concentrations of 423 ± 106 ng m^{-3}. The covariance between the compounds measured was assessed to pinpoint common sources and lifetime of the analytes. Correlations were also checked between them and online AMS measurements of PM_1 chemical composition and the different sources of the organics based on Positive Matrix Factorization of its spectra. The quantified fraction of the organic aerosol (OA) ranged from 8% to 22 % (average OA 9.2 ± 2.8 μg m^{-3}). Part of the unidentified fraction is attributed to compounds (aldehydes, ketones etc.) which cannot be measured with negative electrospray ionization (ESI-). These results are synthesized to provide insights into the sources of OA but also its significant chemical processing under the high OH environment of the Mediterranean in the summertime.

2AC.22

Diurnal Trend and Interconnections of Organic Aerosols and Volatile Chemical Products (VCPs) in a Residential Area.

KYLE MCCARY, Sining Niu, Alana Dodero, Yeaseul Kim, Sahir Gagan, Timothy Onasch, Karsten Baumann, Raghu Betha, Qi Ying, Yue Zhang, *Texas A&M University*

Residential areas are an important source of organic aerosols in urban environments. Exposure to high concentrations of these aerosols in residential areas can contribute to adverse respiratory health effects among local citizens. The emission of organic aerosols from residential areas can be influenced by local gas emissions, leading to further deterioration of air quality. For instance, the increasing concentration of volatile chemical products in urban environments can lead to the production of tropospheric ozone and further oxidation of organic aerosols. This study aims to analyze the emission of organic aerosols in residential areas and their interactions with gas species by combining field data with box modeling. The study specifically focuses on deriving the diurnal trend and interconnections of aerosol particles and VCPs sampled in Cane Island, Katy, Texas, within the Greater Houston Area.

The Texas A&M mobile lab was used for continuous sampling of the ambient gas and particle phase species. The lab was equipped with a high-resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS), a Vocus 2R chemical ionization mass spectrometer (CIMS), an aethalometer, and O_3, CO, CO_2, and CH_4 analyzers. Additionally, temperature and relative humidity (RH) were continuously measured. Positive matrix factorization was used to distinguish local aerosol and gas species. Major VCP tracers, such as D5 and D4-siloxane, monoterpenes, texanol, p-dichlorobenzene, and parachlorobenzotrifluoride were used to estimate the local ozone contribution and their impacts on organic mass concentrations. Statistical analysis was performed using the NumPy and pandas Python packages to gain insights into the interactions between VCP and organic aerosols. This study provides a general overview of aerosol and VCP concentrations and how they vary over a daily timeframe in residential areas. Furthermore, the findings demonstrate that the emissions of organic aerosols and VCPs in residential areas can jointly interact and contribute to the local air quality.

2AC.23

On the Dominant Role of Sulfate Chemistry on New Particle Formation during Summer in Houston.

JEREMY WAKEEN, James Smith, Xuanlin Du, Don Collins, O'Donnell Samuel, Jeffrey R. Pierce, *University of California, Irvine*

New particle formation (NPF) events have been observed in Houston during the summertime, but studies focusing on the gaseous precursors and chemical composition of newly formed particles are lacking. Here we describe results from the TRACER-Ultrafine Aerosol Formation and Impacts (TRACER-UFI) campaign, which took place at the AMF1 main site in La Porte, Texas, from July 1st to August 31st, 2022. The objective of TRACER-UFI is to understand the chemical species and mechanisms responsible for the formation of ultrafine (sub-100-nm diameter) particles in the Houston atmosphere. Our approach combines direct measurements of low-volatility precursors and size-resolved ultrafine particles together with the UC Riverside Captive Aerosol Growth and Evolution (CAGE) chamber, which is designed to remove ambient particles so NPF from the oxidation of local trace gases can be studied. Our measurements will ultimately be coupled with modeling and co-located measurements of particle hygroscopic properties to infer the impacts of ultrafine particles on clouds and climate.

During TRACER-UFI, we measured the composition of ambient 30-60 nm diameter particles using Thermal Desorption Chemical Ionization Mass Spectrometry (TDCIMS), and gas-phase highly oxidized molecules, including sulfuric acid, with nitrate-CIMS. Ambient measurements were alternated with measurements of gases and particles participating in NPF inside the CAGE chamber. During the daytime, we observed NPF each day inside the CAGE chamber, suggesting that ambient concentrations of gas-phase precursors are sufficient to create NPF and growth if the ambient condensation sink were lower. We measured significant amounts of gas-phase sulfuric acid and particle-phase sulfate in both ambient air and the CAGE chamber throughout the 2-month intensive operational period, alluding to the significance of sulfuric acid in NPF and growth in the urban Houston environment in the summertime.

2AC.24

Characterization of Ultrafine Particle Formation from Non-Tailpipe Vehicular Emissions. MADELINE COOKE, Adam Thomas, Michelia Dam, Véronique Perraud, Lisa Wingen, Barbara Finlayson-Pitts, James Smith, *University of California, Irvine*

Ultrafine particles (UFP), particulate matter less than 100 nm in diameter, impact atmospheric chemistry, degrade air quality, and negatively impact human health. Traffic emissions are a main source of particulate matter in urban environments, comprised of two categories: exhaust emissions generated from combustion, and non-tailpipe vehicular emissions generated primarily from brake and tire wear. With the national trend toward replacing combustion vehicles with electric vehicles, non-tailpipe sources are becoming increasingly important. In order to assess how this will impact air quality, it is important to fully characterize these emissions. While research in this area has historically focused on particulate matter in the coarse mode, several recent studies have demonstrated that emissions from brake and tire wear also contain a large fraction of particles in the UFP mode. Number concentrations and elemental chemical composition have been reported, but the physical and chemical (physicochemical) properties of these UFP are not well known. Herein, we investigate the physicochemical properties of UFP from non-tailpipe vehicular emissions and explore how the properties change based on the braking conditions (e.g., temperature, braking torque, friction) and environmental conditions (e.g., exposure to atmospheric oxidants or UV-photolysis). Our results can be applied to better predict how non-tailpipe emissions will impact urban air quality and climate, and provide data useful for mitigating the effects of non-tailpipe emissions moving forward.

2AC.25

Characterization of Chemical Aerosols Generated Using Commercially Available Liquid Aerosol Generators. OYEDOYIN ADUROJA, Kalia Robinson, Cathy S. Scotto, Vasanthi Sivaprakasam, *US Naval Research Laboratory*

We are evaluating a range of commercially available liquid aerosol generators to produce chemical aerosols of controlled characteristics such as aerosol size, mass and concentration. For our current program of interest, we generate simulant aerosols representing various classes of chemicals of interest. Simulants for chemical classes such as caffeine and acetaminophen and inert materials such as NaCl, kaolin and Arizona road dust are used to evaluate the aerosol generator properties. The material of interest is dissolved in water or appropriate solvent and used to generate droplets from the various generators. The generated droplets are dried in an air column and the resultant dry aerosol size distribution and concentration is characterized using particle sizers.

Various types of generators studied here includes atomizing nozzles, atomizing liquids impacted onto hard and soft surfaces, ultrasonic nozzles, and vibrating mesh-based devices. The concentration of the starting chemical solution, the median and width of the droplets generated, the rate of air flow and frequency of operation impacts the characteristics of the resultant dry aerosol. Laboratory studies will be conducted to quantify the range of aerosol size, mass and number concentration achievable for the chemical classes of interest. A numerical analysis has been conducted to characterize the properties of the aerosol for the various generators and will be validated with the experimental results. The analysis and the laboratory results will be presented at the conference.

2AC.26

Brake Wear Emissions of Gas-Phase Sulfuric Acid, Inorganic Nitrogen Species and Oxidized Organics. MICHELIA DAM, Adam Thomas, Véronique Perraud, Lisa Wingen, Barbara Finlayson-Pitts, James Smith, *University of California, Irvine*

Non-exhaust emissions are projected to become the dominant source of traffic-related emissions as our vehicle fleet transitions from combustion engines to electric. Although there is a rapidly increasing body of work showing that braking produces significant particulate matter emissions, characterizing the overall gas emission profile from these braking processes is a key, missing component of understanding their overall effects on health and climate in urban environments. To address this fundamental knowledge gap, we measured gas emissions from two commonly used brake types (semi-metallic, ceramic) using a home-built brake dynamometer and chemical ionization mass spectrometry (nitrate-CIMS and iodide-CIMS). Both moderate and heavy braking conditions were assessed. We found that sulfuric acid, nitrous acid (HONO), other inorganic nitrogen species, and oxidized organics were produced by both brake types, with production rapidly increasing during heavy braking. Measured gases were correlated with other gas compounds emitted during braking (CO, NOx), as well as rotor and chamber temperatures to help determine dominant formation processes and sinks. Ratios of HONO to NOx were found to be higher than those measured from tailpipe emissions during heavy braking conditions. Additionally, the overall magnitude of emissions was found to decrease with increasing wear on the brakes. Our results indicate that brake emissions are a non-negligible source of these reactive gases that impact atmospheric processes including particle formation and growth that need to be considered for effective mitigation strategies in the near future.

2AC.27

Marginal Seas as Receptors and Reactors of Marine Aerosols: A Case Study of the Yellow Sea. ANDREW LOH, Donghwi Kim, Joon Geon An, Narin Choi, Un Hyuk Yim, *Korea Institute of Ocean Science and Technology*

The Yellow Sea is a marginal sea in the Western Pacific Ocean located between mainland China and the Korean Peninsula. With an escalating anthropogenic emission from both land and sea, deterioration of air quality over the Yellow Sea have been continuously reported in the past decade. Air quality over the Yellow Sea is strongly influenced by emissions from China. An air monitoring campaign was performed from February 28 to March 8, 2022, to investigate the chemical characteristics of sub-micron aerosols over the Yellow Sea. The concentrations of all aerosol mass spectrometry identified species and black carbon were highest when winds originated from China, with nitrate (NO_3^-: 38.1 ± 0.37%) dominating over sulfate (SO_4^{2-}: 9.77 ± 0.65%) by over four times. Elevated dinitrogen pentoxide (N_2O_5) and nitric acid (HNO_3) concentrations along with other indicators, including the ammonium-rich conditions, suggested that nighttime heterogenous hydrolysis was a potential source of particulate NO_3^- over the Yellow Sea. A positive matrix factorization (PMF) model identified one natural marine (methanesulfonic acid) and three organic aerosol sources (hydrocarbon-like organic aerosol, low-volatile oxygenated organic aerosol, and biomass burning organic aerosol). The scanning mobility particle sizer showed high particle number size distributions of ultrafine particles ($Dp_{10-35\ nm}$) with winds from Mongolia and Russia, suggesting potential new particle formation events. A strong correlation between the PMF-BBOA source and sum of $Dp_{>100\ nm}$ was observed (r^2 = 0.94), indicating long-range transfers of BBOA over the Yellow Sea. This study is the first to investigate, comprehensively, air masses from China over the Yellow Sea, and provides field evidence of the recent changes in emission trends from SO_4^{2-} to NO_3^-, due to stringent emission regulations.

2AC.28

Non-Volatile Marine and Non-Refractory Continental Sources of Particle-Phase Amine during the North Atlantic Aerosols and Marine Ecosystems Study (NAAMES). VERONICA BERTA, Lynn Russell, Derek J. Price, Chia-Li Chen, Alex K.Y. Lee, Patricia Quinn, Timothy Bates, Thomas Bell, Michael Behrenfeld, *University of California San Diego*

Amines were measured by aerosol mass spectrometry (AMS) and Fourier transform infrared (FTIR) spectroscopy during the North Atlantic Aerosols and Marine Ecosystems Study (NAAMES) cruises. Both AMS non-refractory (NR) amine ion fragments comprising the AMS $C_xH_yN_z$ family and FTIR non-volatile (NV) primary (C–NH_2) amine groups typically had greater concentrations in continental air masses than in marine air masses. Secondary continental sources of AMS NR amine fragments were identified by consistent correlations with AMS NR nitrate, AMS NR f_{44} (the contribution of AMS ion signal at *m/z* 44 (CO_2^+) to the total AMS NR organic mass (OM) signal), ion chromatography (IC) non-sea-salt potassium (nssK+), and radon for most air masses. FTIR NV amine group mass concentrations for particles with diameters <1µm showed large contributions from a primary marine source that was identified by significant correlations with measurements of wind speed, chlorophyll *a* (chl *a*), seawater dimethylsulfide (DMS), AMS NR chloride, and IC sea salt as well as FTIR NV alcohol groups in both marine and continental air masses. FTIR NV amine group mass concentrations in <0.18 and <0.5 µm particle samples in marine air masses likely have a biogenic secondary source associated with strong correlations with FTIR NV acid groups, which are not present for <1 µm particle samples. The average seasonal contribution of AMS NR amine fragments and FTIR NV amine groups ranged from 27±57 % amine from primary marine sources and 73±152 % secondary continental amine during early spring to 53±76 % amine from primary marine sources and 47±68 % secondary continental amine during winter. These results demonstrate that AMS NR and FTIR NV amine measurements are complementary and can be used together to investigate the variety and sources of amines in the marine environment.

2AC.29

Investigate the Vertical Profile of Size-Resolved Aerosol Chemical Composition and Aerosol Mixing State during TRacking Aerosol Convection Interactions ExpeRiment (TRACER). ZEZHEN CHENG, Nurun Nahar Lata, Darielle Dexheimer, Matthew A. Marcus, Gregory W. Vandergrift, Tania Gautam, Chongai Kuang, Allison Steiner, Swarup China, *Pacific Northwest National Laboratory*

This study reports a case study of the vertical gradient of aerosol chemical composition and mixing state. Samples were collected using the automated size and time-resolved aerosol collector (STAC) platform deployed on the Atmospheric Radiation Measurement's (ARM) tethered balloon system (TBS) at the TRacking Aerosol Convection interactions ExpeRiment (TRACER, Houston, TX) ancillary site. TBS has a printed optical particle spectrometer (POPS) and a condensation particle counter (CPC) below STAC to determine particle size distribution. Four STAC samples were collected at different above-ground level altitudes (S1: 0-250 m, S2: 250-500 M, S3: 750-1000m, and S4: 1000-1250m). 72-hour Hybrid Single-Particle Lagrangian Integrated Trajectory model (HYSPLIT) simulation shows that air masses came from the southeast U.S. and across the Gulf of Mexico. We utilized Computer-controlled Scanning Electron Microscopy with an Energy-Dispersive X-ray Spectrometer (CCSEM/EDX) combined with Scanning Transmission X-ray Microscopy/Near Edge Fine Structure spectroscopy (STXM/NEXAFS) to quantitatively probe size-resolved chemical composition and mixing state based on individual particles' relative atomic percentage. The preliminary size-resolved chemical compositions of all samples have bi-modal size distribution (Aitken and accumulation modes), and the relative height of the accumulation mode decreases with increased altitudes. This result is consistent with the POPS size distribution data. Carbonaceous aerosols dominate (>50% by number) in all samples, and the number fraction of sodium-rich sulfate aerosol decreases from ~16% to ~5% with altitude increase. Moreover, particle mixing state were estimated based on the mixing state index (χ). The χ values for all four samples are not significantly different and vary between 35 and 48%, which suggests these particles are not extensively internally mixed and might be less processed in the atmosphere. Results from this study aim to improve our knowledge of the mixing state of the aerosol vertical profile, which can help reduce uncertainties in climate models.

2AC.30

Deep Convective Cloud Formation: Characterization of Secondary Organic Aerosols during TRACER-ARM Campaign. TANIA GAUTAM, Gregory W. Vandergrift, Nurun Nahar Lata, Zezhen Cheng, Darielle Dexheimer, Swarup China, *Pacific Northwest National Laboratory*

Secondary organic aerosol (SOA) formed via gas-phase oxidation of volatile organic compounds (VOCs) can contribute ~90% of the total organic aerosol mass. The molecular composition of SOAs may assist in understanding their chemical transformation, lifetime, and viscosity, which can help in determining the environmental impacts of aerosols. For instance, the increased hygroscopicity of SOA can influence the formation of deep convective clouds. Organosulfates (OSs) and organonitrates (ONOs) are key SOA components which may be crucial in understanding deep convective cloud events. In this study, we aim to characterize the molecular composition of atmospheric particles during the ARM's Tracking Aerosol Convection Interactions Experiment (TRACER) campaign to discern potential molecular level signatures for distinct weather patterns. Samples were collected at ground level. To achieve our goals, we performed direct analysis of atmospheric particles on Teflon substrates using nanospray desorption electrospray ionization (nano-DESI) coupled to high-resolution mass spectrometry (HRMS). Based on our results, we have successfully identified thousands of molecular features, with diagnostic molecular features for particular environmental events (e.g., thunderstorms and convective clouds). Additional efforts are underway to utilize solid phase extraction (SPE) coupled to heated electrospray ionization (HESI)-HRMS to recover molecular fractions susceptible to ionization suppression during direct analyses. Multi-modal chemical imaging techniques have been utilized, such as computer controlled scanning electron microscopy coupled with energy dispersive X-ray spectroscopy (CCSEM/EDX) to characterize the single particle chemical compositions and morphology. Carbon features in the particles were probed with scanning transmission X-ray microscopy with near edge X-ray absorption at fine structure spectroscopy. The results gleaned from our study will assist in identifying key components involved in deep convective cloud formation.

2AC.31

Absorption Spectra and Brown Carbon Chromophores in Particles Emitted by Burning Structural Materials. LUIS RUIZ ARMENTA, Katherine Hopstock, Qiaorong Xie, Kevin Ridgway, Jamie Cast, Shantanu Jathar, Christian L'Orange, Alexander Laskin, Sergey Nizkorodov, *University of California, Irvine*

Fires at the wildland-urban interface (WUI) are increasingly prevalent worldwide. From these fires, large amounts of carbonaceous aerosol particles consisting of black carbon (BC) and brown carbon (BrC) are released into the urban atmosphere. While the BC and BrC emissions from biomass burning have been thoroughly characterized, the chemical composition of aerosols emitted from WUI fires is still poorly understood. Once in the atmosphere, organic compounds in aerosol particles undergo complex chemical transformations affecting their chemical and physical properties. In the case of BrC, the most critical property affected by this chemical aging is the absorption coefficient, which determines the amount of radiative energy trapped by aerosols. This poster reports preliminary findings from the ongoing Burning Homes And Structural MAterials (BHASMA) campaign, focusing on light-absorption coefficients and the chemical composition of smoke released by model WUI fires. Various urban materials, such as structural wood, manufactured wood, sheathing/insulation, siding, roofing, carpet, and electrical wiring commonly found in American households, are burned in two modes: pyrolysis at reduced oxygen level or flaming in presence of normal amount of oxygen. Aerosol particles from the simulated burning of these materials are collected on filters. The chemical composition is analyzed using liquid chromatography coupled with a photodiode array and high-resolution mass spectrometry (HPLC-PDA-HRMS), which separates compounds on a reverse-phase column, detects chromophoric species by their enhanced light absorption and identifies them by a formula using mass spectrometry. This poster is submitted as a late-breaking one as the BHASMA campaign is currently ongoing (June-July 2023), and the first results should be available by the time of the AAAR meeting.

2AC.32

The Influence of Inorganic Salts on the Gas-Aqueous Partitioning of Formic Acid and Acetic Acid. AMIR BABAEI GHAREHBAGH, Rose Taylor, Joy Kiguru, Alyssa Burns, Annmarie Carlton, Christopher Hennigan, *University of Maryland, Baltimore County*

Formic and acetic acid (FA and AA) are the most abundant organic acids in the atmosphere. FA and AA are water-soluble and semi-volatile so they can partition to aqueous droplets and particles in the atmosphere. There is often a significant disparity between measurements and predictions of the abundance and gas-particle partitioning of both acids. Inorganic salts in aqueous aerosols and cloud droplets may alter the partitioning of organics, potentially contributing uncertainty to these predictions. To address this, we conducted experiments using a dual mist-chamber setup to investigate the effects of salt identity, concentration, and pH on the partitioning of FA and AA. The study encompassed various salts, including $(NH_4)_2SO_4$, NaCl, and mixed salt solutions, under pH conditions ranging from 1 to 6, and ionic strengths ranging from 0.01 to 3 mol/kg. Quantification of these measurements was achieved by applying Henry's constant, enabling us to predict the “salting-in” or “salting-out” effects on the partitioning of formic acid and acetic acid. The findings offer valuable insights into interactions between organic acids and inorganic salts in the atmosphere, enhancing our understanding of gas-aqueous partitioning processes.

2AC.33

Organosulfur Speciation in Archean Analog Aerosols: Molecular Characterization and Formation Mechanisms. CADE CHRISTENSEN, Nathan Reed, Jason Surratt, Margaret Tolbert, Eleanor Browne, *University of North Carolina at Chapel Hill*

Earth’s Archean atmosphere is believed to be anoxic and nitrogen rich, containing trace gases such as methane (CH_4), carbon dioxide (CO_2), and sulfur gases. Photochemical gas-phase reactions between these constituents result in inorganic and organic sulfur aerosol formation. The chemical speciation of sulfur aerosols is central to our understanding of Archean atmospheric conditions. Traditional thought holds that only inorganic sulfur aerosols were important sulfur reservoirs. Recent experiments challenge that assumption by showing organosulfur may serve as a sulfur reservoir; however, in-depth molecular analysis had not yet been done to determine the molecular structure and functionality of the constituents. We describe results from laboratory analog experiments using an irradiated mixture of 0.5% CO_2, 0.1% CH_4 and 5 ppm H_2S in a nitrogen environment to investigate the formation of organosulfur aerosols. A hydrophilic interaction liquid chromatography (HILIC) method coupled to electrospray ionization high-resolution quadrupole time-of-flight tandem mass spectrometry (ESI-HR-QTOF-MS/MS) was developed for the molecular-level characterization of resultant particulate organosulfur species. Tandem mass spectrometry (MS/MS) experiments provided details about various functional groups and molecular structure. A complex mixture containing a rich array of molecules was found, ranging from C1-C4 species with sulfur being found in more than one oxidation state. Combining confirmed structures via authentic standards and tentative structural assignments from fragmentation analysis, a proposed gas-phase mechanism for the formation of these compounds is provided to understand the formation and nucleation of these molecules into particulates. These results will help improve our understanding of the atmospheric chemical processes currently found on other planetary bodies and likely during the Earth’s early atmospheric conditions.

2AC.34

Photochemical Production of Light-absorbing Syringol Secondary Organic Aerosol in Droplets using an Atmospheric Simulation Chamber. LELIA HAWKINS, Ellie Smith, Linden Conrad, Jacob Weber, David De Haan, Christian Carmona, Duncan Ugland, Matthew-Khoa Tran, Jean-François Doussin, Mathieu Cazaunau, Aline Gratien, Michael R. Giordano, Mikael Ehn, Frans Graeffe, Liine Heikkinen, Peter F. DeCarlo, Matthieu Riva, Mario Contin, *Harvey Mudd College*

The photooxidation of syringol, a substituted phenol emitted primarily from lignin pyrolysis during wildfires, was used to explore the formation of secondary brown carbon (BrC) under dry, moist, and cloud-like conditions in aerosol and droplet-phase reactions using the CESAM multiphase atmospheric simulation chamber at the University of Paris-Est LISA in Créteil, France. Optical properties were monitored using a particle-into-liquid (PILS) waveguide with total organic carbon (TOC) analysis system while chemical properties were interrogated using two high-resolution aerosol time-of-flight mass spectrometers (HR-ToF-AMS, Aerodyne). Syringol oxidation produced brown, water-soluble products in deliquesced ammonium sulfate (AS) aerosol and in cloud droplets; the limited secondary organic aerosol (SOA) produced on dry AS seed aerosol did not absorb visible light. Browning occurred in simulated sunlight both with and without OH radicals generated by hydrogen peroxide photolysis, as well as in dark conditions with hydrogen peroxide. Brown products formed under dark conditions were different from those formed under light, while products formed in simulated sunlight were chemically and optically very similar whether or not HOOH was present. The aqueous BrC formed without light featured an absorbance peak at 470 nm consistent with a dimer observed previously in this chemical system and disappeared immediately upon illumination. HR-ESI-MS of chamber filter extracts indicates that most products detected by this technique contain N although HR-AMS spectra indicate only a very small contribution from N-containing fragments. UV/visible absorbance spectra and aerosol mass spectra suggest that the products formed in sunlit, OH-mediated reactions are highly similar to those formed under light without an OH radical source, suggesting that direct syringol photolysis may be capable of initiating similar radical-driven chemistry in the absence of additional oxidants like OH or 3C*. However, the actinic flux of the wavelengths of light necessary for this direct mechanism of syringol SOA formation ($\lambda < 280$ nm) is likely too small in the lower atmosphere to be relevant for most biomass burning plumes. Our findings from droplet phase reactions support earlier bulk phase studies suggesting that syringol is capable of forming light absorbing products rapidly in sunlit reactions, especially when liquid water is available.

2AC.35

Mechanistic Insights into NO3 Oxidation of Furfural from Chamber Study. RAPHAEL MAYORGA, Kunpeng Chen, Nilofar Raeofy, Michael Lum, Bradley Ries, Roya Bahreini, Ying-Hsuan Lin, Haofei Zhang, *University of California, Riverside*

Heterocyclic volatile organic compounds (VOCs) are substantially emitted from biomass burning and may represent a significant source of secondary organic aerosol (SOA). Furfural is a heterocyclic VOC that represents a significant portion of these emissions. Despite its relevance, there have been very few experimental studies to uncover the major products and elucidate the chemical mechanism involved in the NO3 oxidation of furfural. In this study, we carried out experiments in a 10 m3 smog chamber to investigate the gas- and particle-phase mechanisms involved in the NO3 oxidation of furfural. The SOA yield from furfural + NO3 was ~0.02. The chemical composition of the SOA from NO3 oxidation of furfural was characterized using a suite of online and offline instrumentation. We propose a mechanism to explain the major products of this system and incorporated this into a chemical box model to compare with laboratory measurements. Previous studies have suggested that initial NO3 attack of furfural should proceed via addition to the double bond rather than by H-abstraction from the aldehyde group. However, some of the identified products from furfural + NO3 SOA are unlikely to form from a NO3 addition-initiated pathway, because they retain their aromatic backbone which would be lost through an NO3 addition pathway. The discrepancy may indicate that the NO3 H-abstraction pathway is more important than previously assumed. Overall, this study will expand the mechanistic understanding of the NO3 oxidation of furfural and will also help to improve future gas- and particle-phase mechanisms of furfural oxidation.

2AP.1

Theoretical Derivation of Particle Collision Kernels from a First-Time-Passage Approach in the Diffusive Regime. JOSÉ MORÁN, Mohammad Reza Kholghy, *University of Minnesota*

The collision kernels of suspended particles in the diffusive regime have been derived analytically based on a theoretical approach that describes the time between collisions as a stochastic variable modeled as a first-time-passage phenomenon. A numerical solution of the Langevin equation for a pair of suspended nanoparticles inspired in the work of Gopalakrishnan et al. (2011) reveals that such distribution is exponential with a parameter proportional to the particle collision kernel and number concentration. This observation is consistent with the theoretical derivation developed in the present work. Though it was not shown mathematically here, we also observe an exponential distribution for particle collisions in the particle-particle transition and ballistic regimes based on Langevin Dynamics simulations under diluted conditions.

The assumption of a diluted regime typically considered in the literature (Fuchs (1965); Friedlander, S. K. (2000)) is lifted and a concentration-dependent expression of the diffusive collision kernel of suspended nanoparticles is obtained analytically. This new expression is in good agreement with numerical simulations from the literature for moderately high levels of concentration (volume fraction < 10%). These new theoretical insights may lead to new venues in the theoretical modeling of aerosol coagulation along different regimes.

[1] Gopalakrishnan, R., & Hogan Jr, C. J. (2011). Aerosol Science and Technology, 45(12), 1499-1509.
[2] Fuchs, N. A. (1965). Physics Today, 18(4), 73.
[3] Friedlander, S. K. (2000). (Vol. 198). New York: Oxford university press.

2AP.2

Neural Network for Soving the General Dynamics Equation for Aerosols. JIANI YANG, Matthew Ozon, Richard Flagan, John Seinfeld, *California Institute of Technology*

Atmospheric aerosols represent a fundamental part of the atmosphere, acting on its physical and chemical properties. Aerosol particles play a predominant role in climate by acting as cloud condensation nuclei (CCN) and ice nucleating particles (INP). Furthermore, they modify the global radiation budget through scattering or absorbing (solar) radiation. However, the radiative forcing effect of aerosols remains hindered by large uncertainties in climate models. The impact of aerosols on radiation is strongly dependent on the size distribution of particles. To better understand the atmospheric physics and chemistry processes contributing to aerosol formation and evolution, we propose an estimation method. The general dynamics equations in terms of number and mass distributions are coupled with kinetic equations to model the time evolution of aerosol population and the chemistry of volatile compounds. From these models and measurement data, we estimate the parameters (along with their uncertainties) dictating the evolution of aerosol systems, e.g. mass concentrations, using artificial intelligence based on data assimilation techniques. This work is a proof of concept for a controlled environment. We demonstrate the applicability of our method using simulated data that resemble real experimental setups. The results of this research would benefit enhancing model prediction and uncertainty quantification of climate change through better estimation of parameters and their uncertainties in climate models.

2AP.3

Chemically-Resolved Volatility of Biomass Burning Emission.

JUN ZHANG, David Bell, Tiantian Wang, Kun Li, Mihnea Surdu, Sophie Bogler, Imad El Haddad, Jay G. Slowik, André S. H. Prévôt, *Paul Scherrer Institute*

Primary organic aerosol (POA) emitted from biomass burning contributes a large fraction of carbonaceous aerosol. These emissions play an important role in air quality, climate, and human health. Volatility is an important property of aerosols because it dictates the partitioning of compounds between the gas and particle phase, thereby affecting their atmospheric fate. The volatility of a compound can be described by effective saturation concentration (C*) at a given temperature and pressure. Many parameterizations are available for estimating the C* of organic aerosol (OA) on the basis of molecular formula.However, there are large uncertainties when applying parameterizations to estimate the volatility of compounds having the same molecular formula but deriving from different OA sources. The dissimilarity between estimated and true values has variable causes including the difference in particle size, phase state, and the activity coefficient of a compound in the OA matrix. Therefore, the volatility of biomass burning OA, as a large contributor to global OA, should be further clarified. Here, we investigate the evaporation behavior of emissions from beech log combustion using a thermodenuder (TD), with real time measurement of the molecular formulae of OA constituents measured by an extractive electrospray ionization time-of-flight mass spectrometer (EESI-TOF). Nearly all the POA measured with the EESI-TOF evaporated in the TD at 100 ℃ with the effective residence time of 6 s. An evaporation-kinetics model was used to retrieve the C*, which was constrained by the empirical relationship between C* and Hvap. The $\log_{10}C^*$ of compounds from beech logs burning varied from -4 to 1 combined with Hvap in the range of ~110 to ~170 kJ mol^{-1}.

We acknowledge the support of the SNF grant MOLORG (200020_188624).

2AP.4

Phase States Linking with Chemical Composition of PM2.5 in Northeast Asia.

CHANGJOON SEONG, Daeun Kim, Rani Jeong, Yanting Qiu, Zhijun Wu, Changhyuk Kim, Kyoung-Soon Jang, Ji Yi Lee, Kwangyul Lee, Joonyoung Ahn, Amgalan Natsagdorj, Mijung Song, *Jeonbuk National University*

The phase state and chemical composition of aerosol particles are key factors affecting their properties and behavior. However, there is a lack of information regarding the impact of chemical composition on the phase state of particulate matter (PM). To address this gap, we investigated how chemical composition affects the phase state of fine PM ($PM_{2.5}$) in four prominent cities: Seoul, Seosan, Beijing, and Ulaanbaatar, during the period from December 2020 to April 2022. We analyzed a total of 92 $PM_{2.5}$ filter samples using optical observation techniques and the Poke and Flow method to investigate the impact of chemical composition on the phase state of $PM_{2.5}$. Our research findings revealed that the range in which $PM_{2.5}$ can exist in liquid and semi-solid states may vary depending on the chemical composition. Specifically, we found that the ratio of nitrate and sulfate in the particle's chemical composition can have an impact on its phase state. By focusing on the impact of aerosol chemical characteristics on the phase state, this study contributes to our understanding of how phase state and chemical composition influence atmospheric pollution.

2AP.5

Particle Size Distribution Measurements for Stratospheric Aerosols in the Range of 0.003 to ~4.0 µm during the SABRE Mission.

MING LYU, Charles Brock, Adam Ahern, Samuel Taylor, Troy Thornberry, Ru-Shan Gao, Eric Hintsa, Colin Gurganus, Andrew Rollins, Eleanor Waxman, Fred Moore, Geoff Dutton, David Nance, Brad Hall, Kristen Zuraski, *CIRES/NOAA Chemical Sciences Laboratory*

The stratospheric aerosol layer plays an essential role in the Earth's radiation budget. Accurate measurement of the concentration and size distributions of stratospheric aerosol particles is crucial in constraining stratospheric radiative effects and their impact on climate. In-situ observations of nucleation mode aerosol particles in the upper troposphere/lower stratosphere are rare, but are of particular importance in understanding the contribution of upwelling ultrafine particles formed near the tropical tropopause and their subsequent evolution in the stratospheric (Brewer-Dobson) circulation.

In the SABRE (Stratospheric Aerosol processes, Budget and Radiative Effects) mission from January to March 2023, we used the Aerosol Microphysical Properties (AMP) instrument suite on a high-altitude aircraft to measure the number concentration and size distribution of aerosol particles in the size range from 0.003 to ~4.0 µm in the lower stratosphere through mid- to high latitudes. Simultaneous trace gas measurements, including O_3, N_2O, SF_6, SO_2, and OCS, were used to investigate dynamical and chemical processes in the stratosphere that determine the evolution of aerosol microphysics. Preliminary results have shown a bimodal structure for stratospheric aerosols in the size distribution; the peak of the small mode is at diameters < 0.1 µm (the troposphere mode), which has not been measured in most previous missions, and the peak for the larger mode is > 0.2 µm diameter (the stratosphere mode). These two modes change as a function of the age of air in the stratosphere (as shown by O_3, N_2O and SF_6), and the evolution in the size of these two modes suggests condensational growth of the troposphere mode particles. These are the first observations of the presence and evolution of this bimodal aerosol structure deep into the stratosphere. The presence of a tropospheric mode of smaller particles in the stratosphere may have implications for proposed geoengineering approaches.

2AP.6

Investigating the Phase State of PM2.5 in Seoul and Beijing using Optical Microscopy and Poke-and-Flow Technique.

MIJUNG SONG, Rani Jeong, Daeun Kim, Yanting Qiu, Xiangxinyue Meng, Zhijun Wu, Andreas Zuend, Yoonkyeong Ha, Changhyuk Kim, Haeri Kim, Sanjit Gaikwad, Kyoung-Soon Jang, Ji Yi Lee, Joonyoung Ahn, *Jeonbuk National University*

The phase state of aerosol particles plays a crucial role in understanding their properties, but information on real-world aerosols remains limited. This study aims to explore the phase state of fine mode aerosols (PM2.5) in two megacities, Seoul and Beijing, during December 2020 – January 2021. Daily PM2.5 filter samples were collected and analyzed using optical microscopy combined with the poke-and-flow technique. The phase states of the PM2.5 bulk were determined as a function of relative humidity (RH) and compared to ambient RH ranges in both cities. Results indicate that PM2.5 in Seoul exhibited a liquid to semisolid phase state, whereas in Beijing, it was primarily semisolid to solid. The liquid phase was dominant on polluted days in Seoul, while a semisolid state prevailed on clean days. These findings can be attributed to the aerosol liquid water content, which was higher in Seoul due to differences in aerosol chemical compositions. Furthermore, the phase states of PM2.5 in both cities were found to be interconnected with particle size distribution. This study contributes to a deeper understanding of aerosol fundamental physical properties and their connection to PM2.5 in urban polluted atmospheres.

2AP.7

Approximating the van der Waals Interaction Potentials between Agglomerates of Nanoparticles. JOSÉ MORÁN, Jerome Yon, Christophe Henry, Mohammad Reza Kholghy, *Carleton University*

Van der Waals (vdW) are probably one of the most important interaction forces between nanoparticles and interfaces found in many applications of aerosol technology spanning filtration, impaction, coagulation, agglomerates restructuring, and resuspension. However, the vdW interactions are currently poorly modeled especially for particles with complex geometry (e.g. raspberry-like and fractal-like agglomerates of nanoparticles).

We have adapted the code FracVAL (Morán et al., 2019) to simulate raspberry-like agglomerates and used its original version to generate representative diffusion-limited (DLCA; fractal dimension 1.78) and ballistic-limited (BLCA; fractal dimension 1.89) agglomerates representing asymptotic limits in agglomeration under diluted conditions as commonly found in aerosol science. We generate a total of 500 agglomerates for each condition to take the particle anisotropy into consideration (relevant for both DLCA and BLCA agglomerates) and generate clusters with a number of primary particles between 10 to 1000. Subsequently, we conducted a detailed morphological analysis of these agglomerates where we determine their anisotropy coefficient, packing factor, pair-correlation stretching exponent, among others. Based on this detailed morphological characterization we model the vdW interaction potential between molecule-agglomerate and agglomerate-agglomerate. For the former case we have obtained analytical equations predicting their orientationally-averaged interaction and for the latter we have introduced a semi-analytical model taking the polydispersity of agglomerates into account and thus extended the work of Babick et al. (2011) focused only on monodisperse DLCA agglomerates of micrometer-sized particles.

These new models may be used in future studies to predict vdW coagulation enhancement, particle-walls interactions, resuspension, impaction, and agglomerate filtration.

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[2] Morán, J., Fuentes, A., Liu, F., & Yon, J. (2019). FracVAL: An improved tunable algorithm of cluster–cluster aggregation for generation of fractal structures formed by polydisperse primary particles. Computer Physics Communications, 239, 225.

2AP.8

Particle Resuspension by Aerodynamic Forces: Drag, Lift, and Torque on a Prolate Spheroid Resting on a Smooth Surface. Patrick Fillingham, IGOR NOVOSSELOV, *University of Washington*

Particle resuspension by air flow has been studied experimentally, and several models for resuspension have been previously proposed. Understanding the aerodynamic forces on particles resting on a surface is important for studies of surface contamination, non-contact sampling, and environmental and health assessments. Though the aerodynamic forces acting on a spherical particle are well studied, in many real-world applications, the particles are non-spherical, and there are currently no established relations for forces on non-spherical particles resting on a surface. We present the relations for the aerodynamic forces on prolate-spheroidal particles attached to a surface in a linear shear flow using direct numerical simulations. The reduced-order model predicts drag, lift, and torque coefficients as a function of the particle aspect ratio, flow incidence angle, and Reynolds number. The predictive model agrees with the direct numerical simulations (DNS) results for the drag and lift coefficients within 0.3% and 3%, respectively [1].

[1] Fillingham, P., et al., Drag, lift, and torque on a prolate spheroid resting on a smooth surface in a linear shear flow. Powder Technology, 2021. 377: p. 958-965.

2AP.9

Retrospective Analysis of Two Decades of Particle Wall-loss Correction from the UCR Dual-90 m3 Collapsible Chamber – A New Dynamic Size-independent Coagulation-corrected Method.

Chen Le, YANYU ZHANG, David R. Cocker III, *University of California, Riverside*

Minimizing uncertainty associated with particle wall-loss corrections are critical for accurately quantifying aerosol yield from environmental chamber experiments. Typically, the experiment-specific, size-independent particle wall-loss rate was derived by fitting the SMPS-measured total particle number decay during the final three hours of the experiment. Particle wall-loss in the UCR previous-generation dual 90-m³ collapsible chambers were enhanced by the charged surfaces of chamber walls. It was previously observed that particles in the chamber tend to approach a charge steady-state during the course of an experiment, resulting in dynamic changes of particle charge distribution as well as the electrostatic enhancement on particle-wall deposition. These resulted in size-insensitivities as well as day-to-day variation of measured electrostatic-enhanced particle wall-loss rates in UCR collapsible chambers. Particle number loss due to particle-particle coagulation could also bias the derivation of particle wall-loss rates, especially when increased particle number loadings were present in the chamber. These observations suggest that real-time particle wall-loss rates do not remain constant during a chamber experiment and therefore use of single wall-loss rate may not accurately describe particle wall-loss over the duration of an experiment. A coagulation-corrected, time-resolved particle wall-loss correction method was warranted to improve wall-loss correction estimates.

A particle coagulation dynamics model was developed in this work to update the particle wall-loss correction for experiments using the UCR collapsible chambers. The model was designed to calculate dynamic particle wall-loss rates after accounting for coagulation and these experiment-specific dynamic values were used to accurately account for both coagulation and particle dynamics. The model was embedded into a MATLAB program to efficiently calculate the particle wall-loss corrections of over 1900 experimental datasets from UCR collapsible chamber experiments conducted during the past two decades. The results verified dynamic changes of particle wall-loss rates within individual experiments, possibly attributed to the changes of particle size, particle charge distribution, chamber surface charge along with chamber geometry. The retrospective summarizes the difference of particle wall-loss rates calculated using traditional and updated correction methods across different years and generations of chamber bags. The particle wall-loss rate discrepancies between the different correction methods grew with increasing particle number loadings. Particle number loss due to coagulation was observed to have a significant impact on the total particle number loss during the first few hours of the experiment when higher particle number loadings were present. Overall, minimum of ~ 5% and ~ 15% overestimation of the final corrected particle volume are determined when coagulation is not accounted for in experiments with at least 10^4 cm^{-3} particles and 5×10^4 cm^{-3} particles, respectively. Preliminary wall-loss corrected data for a series of repeated experiments shows that even maintaining constant initial injections goals, small subtleties still cause measurable bias regarding the generated SOA.

2AP.10

Electrical Charge Characteristics of Brake Wear Aerosol.

ADAM THOMAS, Paulus Bauer, Michelia Dam, James Smith, *University of California, Irvine*

The last few decades have seen a reduction in tailpipe emissions from roadways across the nation, but there nevertheless remains a looming giant of traffic pollution found from non-exhaust sources (e.g., brake and tire wear) that, until recently, has received little attention from the atmospheric science community. Aerosol particles generated from the wear of automotive brake pads contribute to roughly half the particulate mass attributed to these non-exhaust emissions, and their relative contribution to urban air pollution will almost certainly increase as fossil fuels are phased out in the coming decades. In order to better understand the atmospheric implications of their growing prominence, a more rigorous description of their physicochemical properties is needed. The presence of electrical charges on aerosol particles have previously been shown to influence atmospheric lifetimes and coagulation characteristics, thus potentially impacting their ability to serve as seeds for cloud droplet formation. Herein, we describe the first reported measurements on the electrical charge characteristics of brake wear particles. A custom built brake dynamometer was used to generate particles emitted from two widely used types of brake pads. Electrical charge state, as observed for particles of both polarities, was probed using tandem differential mobility analysis, while the total aerosol current and charged particle fraction were also measured. We find that 40-80% of brake wear particles are charged under moderate braking conditions, depending on the brake type. Negatively charged brake wear particles are more numerous than positive, and particles of both polarities are multiply charged, with some carrying as many as 20 elementary charges. In addition to affecting our understanding of how brake wear aerosol behaves in the atmosphere, our findings should also help inform future containment strategies that aim to exploit these particles' electrical properties.

2AP.11

Liquid Smoke as an Optical Surrogate for Biomass-burning Aerosols. Shreya Joshi, Susan Mathai, Swarup China, Nurun Nahar Lata, Timothy Onasch, Arthur J. Sedlacek, Lynn Mazzoleni, Thusitha Divisekara, Simeon Schum, Kyle Gorkowski, CLAUDIO MAZZOLENI, *Michigan Technological University*

Biomass-burning aerosols play a significant role in determining Earth's radiative budget, influencing climate through interactions with radiation and clouds. These aerosols mainly consist of Black Carbon (BC) and Organic Carbon (OC), with BC primarily absorbing and OC predominantly scattering sunlight. The interplay between these two aerosol types, solar radiation, and the atmosphere necessitates a comprehensive study to understand the full impact of biomass-burning aerosols.

Several previous studies on this type of aerosols involved collecting organic carbon directly from the atmosphere or generating them in controlled laboratory conditions by burning selected wood fuels. In this study, we characterized the properties of commercially available liquid smoke as a potential surrogate for biomass burning OC for laboratory investigations. Liquid smoke is a water-soluble flavoring substitute produced by condensing smoke from smoldering wood chips. It is readily available on the market in large batches and it is low cost. Mass spectrometry analysis suggested that the chemical composition of liquid smoke resembles that of biomass-burning aerosol to a high degree (Divisekara et al., 2023). To further determine if liquid smoke can be used as an optical surrogate for biomass-burning aerosols, we compared the optical properties of aerosolized liquid smoke with those reported in the literature and with aerosols generated in the laboratory through the smoldering combustion of wood chips. We used a differential mobility analyzer to select particles of different sizes and utilized several optical instruments including nephelometer and photoacoustic spectrometers, a two-wavelength aethalometer, and cavity phase shift single scattering albedo monitors. We measured high single scattering albedo values and absorption Ångström exponents consistent with weakly absorbing brown carbon. Using electron microscopy on samples collected during the experiments, we determined that the particles are typically spherical in shape as expected for organic particles.

From these preliminary results, we conclude that liquid smoke is a good candidate as an optical surrogate for the study of biomass-burning aerosols to gain insights into the behavior of organic carbon aerosols, how they evolve, and their effects on the atmosphere in controlled laboratory settings.

2AP.12

Simulation of Aerosol Flow in a Nose-Only Inhalation Exposure System Using Ansys Computational Fluid Dynamics (Cfd) Software. SEONGGI MIN, Dong-Jin Yang, Jae-Hyun Kim, Gregory Pellar, Jinghai Yi, Susan Chemerynski, Steven Yee, Reema Goel, Pamela Roqué, Prabha Kc, *NCTR/FDA*

Inhalation chambers are widely used for evaluating the toxicity of chemicals in aerosols, including particulate matter. Ensuring consistent and uniform spatial distribution of aerosols within the inhalation chamber is crucial for accurately assessing toxicity. The CTP/NCTR Inhalation Toxicology Core Facility uses a 5-tier (10 ports/tier) nose-only inhalation exposure system in animal studies. Previous studies have investigated the air flow dynamics within the inhalation chamber. However, the impact of the flow on the concentration and distribution of aerosols is not fully understood. In this study, we used the Ansys CFX 17.2 computational fluid dynamics software to simulate the trajectories and distribution of aerosols across all tiers and ports of the inhalation chamber. A cylindrical rod (crown shaped at the top to minimize air resistance) was inserted into the inhalation chamber. A tier without any output ports was added on the top of the 5th tier of the inhalation chamber to help equilibrate the pressure distribution.

Simulation of aerosol flow (75% propylene glycol/25% water) was performed with 25 rods of varying sizes using k-ω shear stress transport turbulence and discrete phase models. The 5 rods with the smallest relative standard deviation of aerosol flow in the simulation were selected for experimental testing. The aerosol spatial distributions were compared from 8 ports across all 5-tiers of the inhalation chamber simultaneously. Aerosols were generated using a collision nebulizer at 25 LPM of air flow. The rod sizes selected were 40x35, 40x40, 40x45, 40x50, and 45x45 mm.

The difference of aerosol flow between the simulation and experimental results ranged between 0.7-10.44% for all the 5 selected rods. Aerosol concentration throughout the study was within 90-110% of the average value. Overall, this work supports the utilization of simulations in the development of homogenous aerosol flow for uniform dosing in animal inhalation exposures.

2AP.13

Aerosol Deposition in Fully-Developed Turbulent Vertical Pipe Flows: Lagrangian Simulations and Experimental Validation.

FATEMEH RAZAVI, Zack Milani, Nick Ogrodnik, Edgar Matida, *Carleton University*

Aerosol deposition in turbulent pipe flows is a crucial phenomenon with significant implications for various industrial applications, including ventilation systems, pharmaceutical aerosol delivery, and particulate matter transport. This study presents a comprehensive investigation of droplet penetration in fully-developed turbulent vertical pipe flows using Lagrangian numerical simulations. Two Reynolds numbers (ReD = 37,700 and 11,700), representative of the pipe diameter, were considered in the simulations. The characterization of the single-phase flow, encompassing mean velocities, root mean square fluctuation velocities, and turbulence dissipation rate, was obtained by combining law-of-the-wall relationships and direct numerical simulation (DNS) statistical data from the literature. Lagrangian simulations were performed for monodispersed droplets ranging from 1.78 to 26.83 µm, introduced separately into the turbulent pipe-flow computational domain. The droplet phase was modeled using a one-way coupling Lagrangian random-walk eddy interaction model (EIM). A novel approach based on a modified eddy lifetime, derived from local turbulent Reynolds numbers (Reλ) and velocity fluctuations perpendicular to the walls, was proposed to assess droplet penetration. The simulation results were compared against experimental data from Liu and Agarwal, demonstrating overall good agreement and providing validation for the Lagrangian EIM modeling approach. However, some disparities were observed for droplets with dimensions below τ+ < 10 at ReD = 37,700, suggesting the need for further model refinement and calibration. The inherent semi-empirical nature of the current time scale model and the simplicity of the DRW EIM call for cautious consideration of deviations in certain scenarios. In conclusion, this research advances the understanding of aerosol deposition in turbulent pipe flows and provides valuable insights for both the scientific community and some industrial sectors. The Lagrangian simulations, validated against experimental data, serve as a valuable tool to comprehend droplet behavior in complex turbulent environments.

Keywords: Aerosol Deposition, Turbulent Pipe Flows, Lagrangian Particle Tracking, Eddy Interaction Model, Aerosol Behavior, Industrial Applications

2BA.1

Variability in Bioaerosol Particles Emitted from Prescribed Fires and Laboratory Burn Experiments.

KATHERINE BENEDICT, Abu Sayeed Md Shawon, Nevil Franco, Alejandro Gutierrez, Marie Kroeger, *Los Alamos National Laboratory*

Aerosol from biogenic sources or bioaerosol are not well characterized in the atmosphere. However, they appear to have wide ranging impacts from climate to ecosystems to human health. Previous work has shown elevated bioaerosols emitted in the vicinity of biomass fires. In a laboratory setting, we performed controlled burns in a tube furnace using grass, leaf, and evergreen fuels at two temperatures (500C and 1000C) to understand the effect of smoldering and flaming temperatures on the amount and properties of bioaerosol particles emitted. We also sampled emissions from a prescribed fire in the Konza Prairie Grasslands. Bioaerosol particles were measured using Wideband Integrated Bioaerosol Sensor-NEO (WIBS-NEO, DMT). WIBS uses fluorescence excitations (280 and 370 nm) to detect (310-400 nm and 420-650 nm) bioaerosols which are then classified according to fluorescence behavior, size, and a shape parameter. Our preliminary analyses suggest that smoldering and flaming temperatures contribute to emitting different types and shapes of bioaerosol particles. Additionally the emitted bioaerosols from our various fuels have different properties. The type and abundance of bioaerosol from the laboratory experiments will be compared to the prescribed fires.

2BA.2

Seasonal Changes in the Microbiome of a Residential Chicken Coop.

JOHN CATE, Maria King, *Texas A&M University*

The testing of bioaerosols in residential chicken coops to determine the microbiome composition is an under-researched area of study, as most papers tend to focus on the commercial aspect of poultry farming. This study focuses on a residential chicken coop in Texas at different seasons and weather patterns to accurately delineate the fluctuations in the microbiome composition. Testing was conducted in a closed coop setup used during different seasons in colder (winter), warmer (spring), and hotter (summer) weather. This testing allows for a minimal airflow environment in the closed coop in cold weather to compare later with an open coop test. Bioaerosol sampling was completed using a high air volume 100 L/min wetted wall cyclone bioaerosol collector developed at Texas A&M University in the Aerosol Technology Laboratory and a dry filter-based BioFlyte® BioCapture™ z720 collector operating at 200 L/min. After sampling, the bacteria were plated for colony forming unit (CFU) counts, tested for antibacterial resistance using the Kirby-Bauer method, enumerated by quantitative polymerase chain reaction (qPCR) for gene copy number (GCN) counts, and analyzed using Illumina Sequencing for microbiome composition. According to the American Pet Producers Association, about 10 million U.S. households had chickens in 2018, with this number increasing due to rising egg prices. Millions more homeowners can become exposed due to wind dispersing these bioaerosols around neighborhoods and farms. The results show that moving around the coop resuspends hundreds of bacteria per liter air, exposing people to potentially pathogenic microorganisms with antibiotic resistance. The study indicates that installing adequate ventilation and frequent litter removal should protect people working in residential chicken coops from inhaling harmful levels of bioaerosols.

2BA.4

Influence of Rainfall on Taxon-specific Bioaerosols around a Livestock Farm.

NOHHYEON KWAK, Erin Cortus, Carol Cardona, Kristelle Mendoza, Tara Gaire, Noelle Noyes, Jiayu Li, *University of Miami*

Bioaerosols are known to be a crucial factor in the transmission of pathogenic diseases in high-density livestock farming. However, their impact has yet to be thoroughly investigated, and there needs to be more information on size-resolved bioaerosols. Moreover, rainfall represents a liquid-air interface activity that can serve as a potential source of bioaerosols, and its influence on aerosols or bioaerosols is complex. The concentrations of bioaerosols have unique characteristics during rain events. Large particles are washed out by combining rain droplets due to their substantial surface area. In contrast, some aerosols containing microorganisms undergo increased growth during rain, attributed to the agitation and high relative humidity conditions. Therefore, this study aims to address the knowledge gap by identifying the size-resolved bioaerosol information around livestock farms and evaluating the effects of rainfall on bioaerosol concentration and diversity.

This study was conducted beside a livestock barn, and a non-farming environment located 400 m away from the farm. A cascade impactor (Sioutas Impactor, SKC) collected bioaerosol samples with three different size cuts (>2.5, 2.5-1, and 1-0.25 um). The genetic diversity of bioaerosols was analyzed using 16S gene amplicon sequencing targeting the V4 region. Aerosol mass concentration was characterized using an optical particle counter (OPC, Grimm).

The results revealed the presence of marker species around the livestock farm, such as Staphylococcus, Pseudomonas, and Jeotgalicoccus. Bioaerosol concentrations were higher by the livestock farm compared to the non-farming environment. While rainfall decreased the aerosol mass concentration, the bioaerosol concentrations remained stable. During the rainfall, the number concentration of bioaerosols increased in particles smaller than 1 um, indicating a potential influence of rain on bioaerosols. This research will provide valuable information on the concentration and diversity of bioaerosols in the vicinity of livestock farms with size-resolved data. Detailed information on the taxon-specific bioaerosols will be presented.

2BA.5

Indoor Microbial Exposure Differences between Urban and Rural Homes in Central Texas. JUAN PEDRO MAESTRE, David Jarma, Evan Williams, Sharon Horner, Kerry Kinney, *University of Texas at Austin*

The indoor microbiome composition and structure is often a reflection of the outdoor microbiome in the case of fungi, which in turn is affected by global external factors such as latitude but also by more localized factors such as home conditions or the presence of outdoor vegetation, whereas is more a reflection of the human occupancy in the case of bacteria. The influences of urbanization and other localized features on the home mycobiome are still not fully understood. In this study, the fungal assemblages recovered from rural and urban homes in Central Texas were analysed to evaluate their relationship with features of their immediate surroundings and land cover characteristics.

Home information such as household materials, surrounding features, and occupants was collected with an online REDCap survey. Bacterial and fungal communities and semi-volatile organic compound (SVOC) concentrations found in indoor dust the dust were analyzed. Microbial DNA was extracted using the Applied Biosystems, MagMAX Microbiome Ultra Nucleic Acid Isolation Kit and the resultant bacterial and fungal DNA were analyzed, 16S and ITS, on the MiSeq genomic sequencing platform. SVOCs were analyzed with an Agilent GC-MS. The 2016 National Land Cover Data (NLCD) was used to categorize the type of land cover around each participant within a 0.5mi radius.

Findings to date suggest that the degree of development of the land surrounding the homes and the type of land cover could have an impact on the fungal and bacterial diversity inside homes as well as on the community structure. LEfSe analysis indicates that homes in the more developed areas were more enriched in human associated taxa whereas those in less developed areas were enriched with plant-associated taxa. The proximity to cultivation fields also seems to have an impact on the home microbiome diversity and structure. However, the proximity to higher vegetation was not found to have an impact on the diversity and structure of the home microbiome. Finally, the plasticizer DEHP was found to be relevant for the fungal community structure and composition. This study is ongoing, and the relationships between these factors and specific taxa are also being evaluated.

2BA.6

Selective Detection of Airborne Viable Influenza Virus via Capsid Integrity PCR. SANGSOO CHOI, Amin Piri, Jiwoo Jung, Sanggwon An, Jungho Hwang, *Yonsei university*

Airborne viruses cause respiratory diseases and even recent pandemics, so monitoring is important. However, not all airborne viruses exist in an infectious state. Airborne viable viruses potentially cause infection, but non-viable viruses or nucleic acids cannot cause infection. Many of the airborne virus monitoring methods use gold standard PCR as a method of detection.

PCR is a nucleic acid based and has the advantage of being very sensitive and reliable, but it is unknown whether the virus collected from the air is viable. In order to know whether the virus collected from the air is viable, the culture method is essential, but it has the disadvantage of being difficult and taking a long time. Therefore, in this study, capsid integrity PCR was performed by adding a preprocessing step to the normal PCR method to quickly determine the viability of airborne viruses.

Monoazide series and metal complexes were each optimized for liquid phase by treating influenza virus. Of the two, the metal complexes were more effective, so it was successfully applied to laboratory base experiments and also applied to field tests. In further studies, it will be of great help to rapidly measure the viability of airborne viruses in situ by linking Capsid integrity PCR with a POC device.

2BA.7

Evaluation of the Effectiveness of a Hygroscopic Glycerol Coating on MCE Filters on the Conservation of MS2 Viability during Aerosol Sampling. MO WASHEEM, William Vass, Sripriya Nannu Shankar, Yuetong Zhang, Amin Shirkhani, Morteza Alipanah, Z. Hugh Fan, John Lednicky, Chang Yu Wu, *University of Florida, Gainesville*

Conservation of viable viruses collected onto membrane filters is hampered by inactivation of viruses due to desiccation during air sampling. Whether increasing the hygroscopicity of such filters can improve the viability conservation of bacteriophage MS2 during air sampling was explored in this study. First, mixed cellulose ester filters coated with a humectant (glycerol) were assessed at the benchtop scale to determine whether the glycerol detrimentally impacted the viability of MS2. The coating was accomplished by soaking as-packaged filters (APF) in 10% glycerol and baking the filters at 100 °C for 30 minutes. Averagely 121% more viable MS2 was recovered from glycerol-coated filters (GCF) than APF, indicating that glycerol has no detrimental effects on MS2 viability ($p=0.031$). MCE filters in three configurations - APF, GCF, and PBS-wetted filters (PWF) were then tested with aerosolized MS2 at two relative humidities (RHs), 50% and 80%, with a gelatin filter (GF) as a reference, and the GCF was preconditioned for 30 minutes at 80% RH before aerosol sampling at the same RH. The PWFs failed due to a large pressure drop. The results at the lower RH showed statistically similar ($p>0.05$) mean total genomic equivalence for all filter types, but the viable collection by GCF at this RH was significantly lower than other filters ($p<0.05$). On the other hand, at the higher RH, GCF showed 2.3 times the viable virus recovery of APF and 3.7 times that of GF ($p<0.0001$). Furthermore, experimental results with preconditioning of GCF and APF with moisture before aerosol exposure at 50% and 80% RH, showed GCF's capability of viability conservation at 80% RH even without preconditioning. Thus, the moisture availability in virus aerosols at high RH (80%) was found to be the key parameter in providing an adequate amount of moisture on the filter surface to keep the collected virus viable.

2BA.8

Airborne Algicidal Bacteria May Control Phytoplankton Cell Fate in the Oceanic Blooms. NAAMA LANG-YONA, J. Michel Flores, Inbal Nussbaum, Ilan Koren, Assaf Vardi, *Weizmann Institute of Science*

Ocean microbes are involved in global processes such as nutrient and carbon cycling. Recent studies indicated diverse modes of algal-bacterial interactions, including mutualism and pathogenicity, which have a substantial impact on ecology and oceanic carbon sequestration, and hence on climate. However, the airborne dispersal and pathogenicity of bacteria in the marine ecosystem remained elusive. Here we isolated an airborne algicidal bacterium, *Roseovarius nubinhibens*, emitted to the atmosphere as primary marine aerosol and collected above a coccolithophore bloom in the North Atlantic Ocean. The aerosolized bacteria retained infective properties and induced lysis of *Emiliania huxleyi* cultures. This suggests that the transport of marine bacteria through the atmosphere can effectively spread infection agents over vast oceanic regions, highlighting its significance in regulating cell fate in algal blooms.

2BA.9

Darwin's Dust and the Search for Signs of Ancient Life on Mars.

HANS MOOSMÜLLER, *Desert Research Institute*

When Charles Darwin undertook his famous voyage around the world on the HMS Beagle, his first landing was on the Cape Verde Islands on 16-Jan-1832. Upon arrival, Darwin encountered a dust storm near the island of Santiago. Darwin collected samples of dust deposited on board the Beagle and send the samples to Professor Ehrenberg (University of Berlin, Germany), who found that "this dust consists in great part of infusoria with siliceous shields [i.e., shields of diatoms], and of the siliceous tissue of plants." Darwin concluded from the samples, the wind direction, and the general meteorological conditions during wintertime that the dust originated from ancient freshwater lakes in Africa, more than 600 km away. Therefore, Darwin was able to observe remotely that life had existed in Africa at some time. Similar conclusions can be made from examination of African dust transported to the Caribbean or the Amazon.

The current search for signs of ancient life on Mars is focused on using a rover to examine local soil samples from the delta of an ancient river, where life may have occurred. In addition, soil samples are stored, for retrieval during a planned sample return mission, for further examination on Earth. Inspired by Darwin's observations of signs of life in mineral dust aerosols on Earth, one may imagine a different paradigm for searching for signs of ancient life on Mars, based on the examination of mineral dust. Mars aerosols are completely dominated by mineral dust cycled, that is entrained and deposited, all over Mars. Therefore, it would be possible to obtain and examine mineral dust from all of the Martian surface at a single surface location. Examination of deposited mineral dust for signs of life could be done with optical or electron microscopy or after sample return to earth.

2BA.10

Validation of Air Sampling Methods Inside the Heating, Ventilation, and Air Conditioning (HVAC) Inside Student Dorms Using an Improved qRT-PCR Analysis Method.

SINAN SOUSAN, Marina Boatman, Lauren Johansen, Ming Fan, Rachel Roper, *Department of Public Health, East Carolina University*

The COVID-19 pandemic forced institutions to adopt remote learning methods that presented obstacles and minimized social interactions weakening the learning process and creating mental health problems. Due to these events, these institutions reopened face-to-face learning and enforced mitigation strategies to limit the spread of the disease and sustain on-campus activities. This work validated a previously established method to detect the SARS-CoV-2 virus responsible for COVID-19 disease inside the Heating, Ventilation, and Air Conditioning (HVAC) system of student dorms. This was accomplished by performing air sampling using different methods and media types combined with qRT-PCR analysis inside two environments during the Fall semester. The first was the unknown environment, without the knowledge of a COVID-19 case in the dorm, by sampling air from the HVAC system that represents the return air for the entire dorm. The second was the known environment to compare the different methods and media types used by sampling air directly from the HVAC system of a suite occupied by a COVID-19 positive student. The air sampling methods were performed using Filter Cassettes, Button Sampler, BioSampler, and AerosolSense Sampler. For the Button Sampler, four media types for the 25-mm filter were used with different pore sizes of 5 µm, 3 µm, 3 µm (gelatin), and 1.2 µm. The SARS-CoV-2 positive air samples were compared with the positive samples collected by campus track tracing methods using PCR testing on saliva and nasopharyngeal samples. The results show a detection rate of 17% in the unknown environment using the Button sampler (25-5) and a 65% detection rate in the known dorm. However, the detection rate was different by method, with 25% for Filter Cassettes, 39% for Button Sampler with 25-5, 19% for Button Sampler with 25-1.2, 17% for Button Sampler with 25-3 gel, 39% for BioSampler, and 13% for AerosolSense Sampler.

2BA.11

The Microfluidic Aerosol Sampler System (MASS). LEAH TALBOTT, Andrea Timm, Ryan Darragh, Gregory Merboth, Christopher Stiles, Corrine Morrison, *Johns Hopkins University Applied Physics Laboratory*

Traditional bioaerosol samplers utilize dry filters or liquid media. However, these techniques are limited: samples require pre-analysis processing (not real-time), have low recovery rates, and use large volumes (mL). Size, weight, and power (SWaP) requirements also limit portability and scalability for field operations. Microfluidic systems that can continuously operate and be integrated with approaches for rapid detection have the potential to produce enriched samples due to low liquid-to-aerosol volume ratios (≤µL). These low cost systems are rapidly emerging as alternatives to conventional bioaerosol sampling systems. In a previous study (A Microfluidic Inertial Aerosol Sampler for Continuous, Efficient Collection and Near Real-Time Detection of Bioaerosols – presented in 2020), we performed redesign and preliminary investigations of the physical collection efficiency (CE) of the of the MicroSampler (Choi et al., ACS Sensors), a microfluidic inertial aerosol sampler, for the purpose of viral aerosol collection. Two-phase stratified flow (sampling air and collection liquid) and inertial deposition provide efficient aerosol collection. As aerosols traverse the curved region of the sampler, centrifugal and drag forces result in the transfer of aerosols from sampling air to collection liquid. In this work, we expanded CE analysis using salt particles (~15 nm to 10 µm diameter) and a Scanning Mobility Particle Sizer (for nm) or Aerodynamic Particle Sizer (for µm), which measured particle concentration upstream and downstream of the sampler. The MicroSampler based design had CE>70% for particles ~15 nm to 500 nm and CE>97% for particles ≥0.5 µm. In addition to experiments, we evaluated commercially available technologies and 3D printing techniques to design a sampler capable of 8-hours of continuous operation. Results indicate that the microfluidic sampler can provide continuous, efficient aerosol sampling for bioaerosols across a variety of flow rates at low cost and with low SWaP.

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2BA.12

Implementing a Portable Biofilm Fluorescence Monitoring System for Enhanced Bioaerosol Source Control. JAE HEE JUNG, In Ho Kim, Jae Hak Shin, *Sejong University*

Biofilms, microscopic entities commonly found on surfaces, serve as potential reservoirs for airborne microorganisms and contribute to a number of problems, including disease outbreaks and degradation of structures and devices. This research was structured around the optical characterization of Staphylococcus epidermidis bacterial biofilm growth with the goal of building an effective optical monitoring system, which is designed to enhance biofilm management and thus significantly improve indoor air quality by reducing bioaerosols generated from biofilms. The optical properties of the biofilm were evaluated using a variety of approaches. First, a metric for the density of microorganisms in the biofilm was established, calculated by measuring the colony concentration per unit area under different growth time conditions. In parallel, a microscopic evaluation was performed to describe the structural formation of biofilms cultured under similar conditions. Ultraviolet-visible and fluorescence spectroscopy were applied to measure various optical properties, particularly absorption and fluorescence spectra. In a subsequent step, the system optics were designed according to the optimal optical measurement conditions identified for biofilm monitoring. A signal processing technique was developed to reduce interference from ambient light. This technique significantly increased the sensitivity of the system, enabling it to measure the fluorescence of weak biofilms under different indoor lighting conditions. A comparative analysis was performed to assess the bioaerosol concentration in proximity to the biofilm with and without the system, with a focus on characterizing bioaerosol management in both scenarios. Overall, this study highlights the potential for introducing an effective bioaerosol source management system, providing a scientific basis for advances in the field of bioaerosol management.

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2CA.1

Pyrocumulonimbus Black Carbon Morphology and Mixing State Control Direct Radiative Effect. PAYTON BEELER, Joshin Kumar, Joshua P. Schwarz, Rajan K. Chakrabarty, *Washington University in St. Louis*

Atmospheric black carbon (BC) aerosol is an important component of Earth's climate system in part because of its ability to absorb incoming solar radiation. Among the largest sources of atmospheric BC are wildfires and other types of biomass burning. High-energy wildfires can produce pyrocumulonimbus events (pyroCbs) that inject smoke into the upper troposphere and lower stratosphere (UTLS), where it can remain suspended for several months. Because of BC's ability to absorb incoming sunlight, it is predicted to have a net positive direct radiative effect (DRE) and be an atmospheric warming agent. However, the location of BC in the atmosphere and its mixing state with non-BC materials have significant impacts on the DRE of BC. PyroCb BC particles in particular are unique because of their mixing state with other non-BC materials, which manifest as thick coatings on the surface of BC. Previous studies have produced conflicting estimates of the DRE of BC from a pyroCb event, which may be due in part to differing representations of BC morphology and mixing state in radiative transfer models. This study utilizes particle-resolved measurements from within a pyroCb plume and particle-resolved simulations to benchmark the effectiveness of different BC model parameterizations in calculating the DRE of pyroCb BC. We find that the DRE of pyroCb BC is highly dependent on the choice of BC representation when calculating BC optical properties, and that detailed representation of BC mixing state is required for more accurate estimation of BC DRE.

2CA.2

Aggregation Induced Enhancements in Aerosol Absorption and Scattering across the Black-Brown Continuum. JOSHIN KUMAR, Payton Beeler, Benjamin Sumlin, Rajan K. Chakrabarty, *Washington University in St. Louis*

The global radiative forcing of carbonaceous aerosols is one of the largest sources of uncertainty in current climate models. BrC is an amorphous organic aerosol formed in biomass burning events, such as wildfires, and its radiative impact remains poorly understood. Aggregates of BrC primary spheres (monomers) have been recently observed in abundance in wildfire smoke. Aggregation could alter their optical properties and direct radiative forcing, yet very little is known about this phenomenon. This study could improve the representation of BrC aerosols in climate models by enhancing the current understanding of their optical properties.

In this study, we utilize the framework presented by Saleh et al. (2020) for the optical classification of particles in the black-brown continuum but focus on two sub-classes of BrC: dark brown carbon (d-BrC) and weakly-absorbing brown carbon (w-BrC). We calculate and compare the mass absorption coefficient (MAC), mass scattering coefficient (MSC), single scattering albedo (SSA), asymmetry parameter of dark brown carbon (d-BrC) and weakly-absorbing brown carbon (w-BrC), and determine their absorption and scattering enhancements due to aggregation. We use polydisperse diffusion limited cluster-cluster aggregation simulations to generate 90 aggregates of varying monomer diameters, and discrete dipole approximation to calculate optical properties of aggregates at different refractive indices, monomer diameters, and incident wavelengths.

BrC aggregate's optical properties are more sensitive to the number and mean diameter of monomers than their polydispersity. d-BrC has almost twice the MAC of w-BrC at 350 nm, but w-BrC has MSC values almost double that of d-BrC. Both MAC and MSC decrease with wavelength. Aggregation enhances optical properties, with smaller size parameters and lower imaginary part of the complex refractive index of aggregates resulting in stronger absorption and scattering.

Reference: Saleh, R.: From measurements to models: toward accurate representation of brown carbon in climate calculations, Current Pollution Reports, 6, 90-104, 2020.

2CA.3

Apportionment of Primary and Secondary Carbonaceous Aerosols Using an Advanced Total Carbon – Black Carbon (TC-BC(λ)) Method in Southern California. MATIC IVANČIČ, Asta Gregorič, Gašper Lavrič, Bálint Alföldy, Irena Ježek Brecelj, Payam Pakbin, Faraz Ahangar, Mohammad Sowlat, Steven Boddeker, Sina Hasheminassab, Martin Rigler, *Aerosol d.o.o.*

Carbonaceous aerosols (CA) have a negative impact on public health and Earth's radiative balance. They are characterized by extreme diversity and comprise a large fraction of ambient fine particulate matter (PM2.5). The apportionment of CA to more components is crucial to prepare efficient measures to improve local air quality and create effective mitigation strategies to limit further warming on a global level. In this study, we used the Carbonaceous Aerosol Speciation System (CASS, Aerosol Magee Scientific, Slovenia, EU), comprised of two instruments, a Total Carbon Analyzer TCA08 in tandem with an Aethalometer AE33, which allows us to perform high-time-resolution measurements of total carbon (TC) and black carbon (BC). Integrating different numerical algorithms to high-time-resolution measurements with CASS, we recently published an advanced method to apportion CA into six components based on their optical absorption properties and their primary or secondary origin: $CA=BC_{ff} + BC_{bb} + POA_{BrC} + POA_{non-abs} + SOA_{BrC} + SOA_{non-abs}$,

where BC_{ff} and BC_{bb} represent fossil fuel and biomass burning related BC components, POA_{BrC} and SOA_{BrC} are the primary emitted and secondarily formed light-absorbing organic aerosols (brown carbon, BrC), and $POA_{non-abs}$ and $SOA_{non-abs}$ non-light-absorbing aerosols.

The multi-year and high-time-resolution CA measurements were performed at different measurement sites in Southern California operated by South Coast AQMD. Similar temporal patterns were observed at all locations: the morning rush hour traffic, especially in winter, resulted in the contribution of primary emitted carbonaceous aerosols ($BC_{ff} + BC_{bb} + POA_{non-abs} + POA_{BrC}$) up to 90% of the total CA. On the other hand, secondary formed SOA ($SOA_{non-abs} + SOA_{BrC}$) is a dominant component of CA in summer afternoons when their contribution can reach 80% of the total CA. Considering the methodology limitations and recommendations, we believe the presented measurement system and methodology have a high potential to be implemented for real-time analyses.

2CA.4

A Novel Approach to Black Carbon Generation: Automated Soot Generation System Leveraging Real-Time Feedback for Enhanced Precision and Cost Efficiency. KYAN SHLIPAK, Jeff Blair, Steven Blair, L. Drew Hill, *Aethlabs*

Black carbon (BC), a toxic, carbonaceous aerosol, has increasingly been tied to various adverse health effects, compelling community and policy driven measures to include BC monitoring in public health and climate action plans. Despite the need, there is currently no standard for calibrating real-time BC monitors to ensure accountability across technologies and manufacturers. Precise and affordable controlled BC generation would be an invaluable step towards such a standard. Recent projects developing precise BC generation systems have used inverse flame soot generation in dilution-based systems. However, dilution-based BC generation systems are sensitive to daily environmental variables, such as temperature, soot accumulation, humidity, and flame characteristics, leading to significant error between target and observed BC concentrations. We developed a novel automatic black carbon generation system (ABCGS) integrating an inverse flame soot generator and leveraging a real-time concentration feedback loop to improve the accuracy, ease of use, and reliability of precise BC generation systems. Rather than trying to fix each environmental condition, the ABCGS obviates the need by characterizing and adjusting to the behavior of BC concentrations over time, substantially reducing the total construction cost of precise BC generation systems. The ABCGS utilizes electronic components, Python scripting, and a graphical user interface to sequentially reach and maintain predefined BC concentrations for user-specified durations. It can currently test up to 57 BC monitoring devices simultaneously, though larger capacity sampling plenums are in development. Preliminary results suggest the ABCGS can consistently and precisely produce BC concentrations from just 2 $\mu g/m^3$ to over 100 $\mu g/m^3$ with an absolute error typically within 0.5 $\mu g/m^3$ + 4% of the goal concentration, suggesting the system can be used to test and calibrate black carbon monitors. We present the results of additional testing conducted to determine the long-term performance of the soot generation system.

2CA.5

Near Infrared-Absorbing, Non-Black Carbon Particulate Material from Biomass Burning. TIMOTHY ONASCH, Ernie R. Lewis, Arthur J. Sedlacek, *Aerodyne Research, Inc.*

Biomass burning produces two classes of light absorbing particles: black carbon (BC) and light- absorbing organic commonly referred to as brown carbon (BrC). BC particles absorb throughout UV, visible, and near-IR wavelengths, whereas BrC particles absorb mainly in the UV-VIS. Recent field and laboratory studies have identified, and begun to quantify, BrC that absorbs light from the UV-VIS out to the near infrared (NIR), which we call NIR-BrC. Examples of such particles are tar balls and BrC strongly associated with BC. NIR absorption by organic material from biomass burning represents a positive longwave radiative forcing. For example, while BC has an approximately 10x greater mass absorption cross-section than tar balls at 950 nm, tar balls can be present in near-source biomass burning plumes at 5-10x greater mass concentrations than BC, resulting in roughly the same absorption by both types of particles at 950 nm.

The Soot Particle Soot Photometer (SP2) can be utilized to detect NIR absorption by NIR-BrC particles. Here we are working to extend the novel SP2 analysis technique described by Corbin and Gysel (2019), which uses the time series of the scattering signal of non-BC-containing particles to determine if absorption of the 1064 nm laser energy results in particle shrinkage. We are applying this technique to ground-based SP2 measurements of smoke plumes collected as part of the 2019 FIREx campaign. This technique offers the unique potential for providing particle-resolved measurements of NIR-BrC, an estimate of the fraction of OA that absorbs in the NIR, and a basis for delineating the NIR absorption contributions between BC and NIR-BrC. These observations may provide an important quantitative assessment of NIR-BrC particles and their importance to radiative forcing.

2CA.6

Comparison of Black and Brown Carbon Emission Factors, Pollutant Ratios and Optical Properties in Prescribed Burn and Wildland Fire Smoke in California. Rebecca A. Sugrue, Farrah Haeri, Chelsea V. Preble, Deep Sengupta, Nathan Kreisberg, Paul Van Rooy, John Battles, JAMES D.A. BUTLER, Coty Jen, Kelley Barsanti, Allen Goldstein, Thomas W. Kirchstetter, Afsara Tasnia, Robert York, Scott Stephens, *University of California, Berkeley*

Climate change and a build-up of excess fuel loads over the previous century are contributing to an increase the frequency and intensity of wildland fires in the western United States. Prescribed burns are a low-cost and effective fuels management practice to ensure healthy and climate resilient forests long employed by indigenous peoples. Wildland fires and prescribed burns alike generate fine particulate matter (PM2.5) and other toxic air pollutants that are climate pollutants and degrade air quality in downwind communities. Black carbon (BC), a component of PM2.5 and a short-lived climate pollutant, was measured on a ground-based utility vehicle platform with a multi-wavelength dual-spot aethalometer and on an aerial-based drone platform with the UC Berkeley low-cost aerosol black carbon detector (ABCD). CO and CO2 were measured alongside BC to calculate fuel-based emission factors during four prescribed burns in a productive mixed conifer forest at the Blodget Forest Research Station. We also measured BC and PM2.5 from aged wildland fire smoke with a distributed network of 24 ABCDs in Richmond, CA during August 2020 and obtained BC, PM2.5 and CO measurements at regulatory sites in the SF Bay Area and Los Angeles for 2018-2020. Brown carbon (BrC) concentrations and the absorption Angstrom exponent (AAE) were determined from BC data measured with a multi-wavelength aethalometer and informed when regulatory sites were impacted by wildfire smoke. For the low-cost distributed network and regulatory sites, the black carbon to fine particulate matter ratio (BC/PM2.5) and BC to CO enhancement ratio (DBC/DCO) attributable to wildland fire smoke were calculated. Emission factors and pollutant ratios measured at the prescribed burns, by the low-cost distributed network, and at regulatory sites will provide more accurate emissions estimates to constrain California's BC emissions inventory and as inputs to a first-order fire effects model (FOFEM).

2CA.7

Characterizations of Black Carbon Aerosols from Southeast U.S. Prescribed Fires and Western U.S. Wildfires. ANDREW METCALF, Dongli Wang, *Clemson University*

Biomass burning from prescribed fires and wildfires are two important sources of carbonaceous aerosol in the atmosphere. Although the western U.S. receives noteworthy publicity for the wildfires which occur there almost every year, the southeastern U.S. actually has far more prescribed fires. Such fires have a significant impact on air quality and local visibility. However, field measurements of aerosol emissions from small, prescribed fires are relatively sparse. Black carbon (BC) is one of the important aerosol emissions from open biomass burning, affecting air quality and human health on regional scale. BC is also an efficient light-absorbing aerosol component and thus affects radiative transfer in the atmosphere. Optical properties are critical parameters determining the impacts of aerosol emissions on climate and are highly dependent on aerosol composition.

In this presentation, BC aerosol emissions from prescribed fires in the southeast U.S., from both historical and recent measurements, are compared to emissions from wildfires which predominantly occur in the western U.S. A scanning electrical mobility spectrometer (SEMS) is used to measure the total submicron aerosol size distributions, and a Single Particle Soot Photometer (SP2) is employed as the primary measurement of BC aerosol number and mass mixing ratios, mass and size distributions, and number fractions of coated and uncoated BC-containing aerosol particles. Measurements of western wildfires were conducted on an aircraft campaign, while measurements of southeastern prescribed fires were ground-based. Studying the difference in these two emission sources will provide information for emission inventories to better predict the impact on air quality and the climate system from BC aerosol.

2CA.8

Impacts of a Large Wildfire on Regional Ozone and PM2.5 Considering the Light Absorption of Brown Carbon. MINSU CHOI, Jie Zhang, Qi Ying, *Texas A&M University*

The enhanced UV absorption of wildfire brown carbon (BrC) on the formation of O_3 and fine particulate matter ($PM_{2.5}$) is, for the first time, evaluated using a modified community multiscale air quality (CMAQ) model with wavelength-dependent imaginary refractive indexes for primary and secondary organic aerosols. On high emission days of the Bastrop County Complex fire in Texas in early September 2011, BrC UV absorption reduces the daytime average NO_2 photolysis rate by up to 38% in the core region of the wildfire plume compared to the base case that does not consider BrC absorption. Consequently, the predicted daytime increase of O_3 due to wildfire emissions is uniformly lower throughout the mixing layer than the base case due to reduced HOx radical concentrations. In the core region, the predicted O_3 increase due to wildfire reaches as high as 47-123 ppb in the base case, but the increase is reduced by 4-19 ppb when BrC absorption is considered. While the fire emission leads to increases of PM2.5 up to 200-300 $\mu g\ m^{-3}$, considering BrC light absorption only leads to a small reduction of $PM_{2.5}$ by ~1% because secondary aerosols only account for a small fraction of the total $PM_{2.5}$ in wildfire impacted regions. Our study demonstrates that UV absorption by BrC must be considered in evaluating the impact of wildfires on O_3 air quality, and the assumption of the aerosol mixing state (core-shell vs. homogeneous) in the online photolysis rate calculation would not significantly affect the evaluation results.

2CA.9

Analysis of Wildfire Aerosol Aging Using the ASCENT Network Observations. YINGJIE SHEN, Shane Murphy, Jason Surratt, Nicolas Aliaga Buchenau, Jose-Luis Jimenez, Douglas A. Day, Seonsik Yun, Nga Lee Ng, Ann Dillner, Roya Bahreini, Armistead G. Russell, *University of Wyoming*

Black carbon (BC) and Brown carbon (BrC) emissions from wildfires absorb near UV - visible sunlight and impact the global climate. Wildfires are one of the largest sources of both BC and BrC (both primary and secondary), and with the increasing number of wildfires in the United States and globally, the absorption caused by BC and BrC are of growing importance. The contribution of absorption from BC and BrC does not remain constant during their evolution, due to secondary BrC production and photobleaching. However, this evolution process still remains uncertain, largely due to the difficulty of tracking the same fire plume over multiple days of aging and because of variability that is caused by burning conditions versus aging. In this presentation we will present analysis of wildfire aging using measurements from multiple ASCENT (Atmospheric Science and Chemistry mEasurement NeTwork) sites. The ASCENT network consists of 12 sites across the US, which gives us opportunities to keep track of the long-distance transport of the same fire plumes over the country. We will present results on the impact of dilution and physical aging on the contribution of fires to BC and BrC, as well as the relationship of optical properties to aerosol chemical composition.

2CA.10

Composition and Surface Tension of Surface-Active Organics in Biomass Burning Aerosol. ARIANA DEEGAN, Chase Glenn, Omar El Hajj, Kruthika Kumar, Anita Anosike, Joseph O'Brien, Rawad Saleh, Amanda Frossard, *University of Georgia*

The organic fraction of biomass burning aerosol contains humic-like substances (HULIS), some of which have been shown to be surfactant-like. Current work is investigating the surfactant fraction of biomass burning aerosol and its influence on the ability of particles to act as cloud condensation nuclei. In this study, aerosol particles were collected from the Georgia WIldland-fire Simulation Experiment (GWISE). Biomass from three Georgia ecoregions (Piedmont, Coastal, and Blue Ridge) were combusted with two moisture contents (low and high), resembling wildfire and prescribed fire conditions, respectively. A Potential Aerosol Mass Oxidation Flow Reactor (PAM-OFR) was used to replicate photochemical aging. Particles were extracted from filters, and organic compounds were isolated using two solid phase extractions. UV-Vis spectroscopy coupled with colorimetry was used to measure concentrations of anionic and cationic surfactants in the organic extracts. Tensiometry was used to measure surface tension isotherms and surface tension minimums and calculate critical micelle concentrations (CMCs). We show that the relative fraction of surfactants in the aerosol particles and the surface tension minimums of the surfactants vary as a function of biomass fuel type and moisture content. Across all fuels and moisture contents, anionic surfactants were the most prevalent. The Coastal fuel type, under the wildfire conditions, produced aerosol particles with the highest relative concentrations of surfactants. Surface tension minimums ranged from 33 to 46 mN m^{-} for organics extracted from particles produced across all fuel and moisture types. The aged particles had larger surface tension minimums than the fresh samples, in each experimental pair. The average CMC of the organic extracts was 0.256 mM. The surfactant concentration and surface tension depressions highlight the influence of fuel type, burning conditions, and aging on the composition and physical properties of surface-active organics in biomass burning aerosol.

2CA.11

Light-absorbing Carbonaceous Aerosol Emissions from Biomass Burning under Wildfire and Prescribed-fire Conditions. CHASE GLENN, Omar El Hajj, Anita Anosike, Kruthika Kumar, Robert Penland, Joseph O'Brien, Rawad Saleh, *University of Georgia*

The Georgia Wildland-fire Simulation Experiment (G-WISE) involved burning forest-floor fuel beds constructed from surface fuels with proportions representative of 3 ecoregions in Georgia. The burns were performed under moist (prescribed fires) and dry (drought-induced wildfires) conditions. Here, we present the relative elemental carbon (EC) and organic carbon (OC) emissions, as well as brown carbon (BrC) light-absorption properties for 3 fuel bed scenarios: (i) surface fuels burned under wildfire conditions (W), (ii) identical surface fuels burned under prescribed conditions (Rx), and (iii) surface fuels with duff, burned under wildfire conditions (W-DUFF).

The EC/OC ratio for W was approximately 2.5 times higher than Rx, signifying the effect of fuel moisture content on burn conditions and consequently carbonaceous aerosol emissions. W-DUFF emissions were OC dominated with negligible EC, indicating the impact of duff on wildfire smoke composition.

We retrieved the BrC imaginary part of the refractive index at 550 nm (k_{550}) and wavelength dependence (w) using optical closure. The process involved Mie calculations, photoacoustic spectrometer light-absorption measurements (422 nm, 532 nm, 785 nm), size distribution measurements, and black carbon absorption estimated from optical calculations using EC/OC measurements. The results were as follows: W (k_{550} = 0.015 and w = 1.3), Rx (k_{550} = 0.006 and w = 2.7), and W-DUFF (k_{550} = 0.001 and w = 5.3), indicating BrC optical properties have strong dependence on burn conditions.

We collected filter samples and retrieved k_{550} and w of the methanol-extracts from UV-Vis absorption measurements. The results for the methanol-soluble BrC (MSBrC) were as follows: W (k_{550} = 0.001 and w = 7.1), Rx (k_{550} = 0.002 and w = 6.2), and W-DUFF (k_{550} = 0.001 and w = 6.5). These findings indicate that MSBrC approximates weakly-absorbing BrC aerosol (W-DUFF), but underestimates BrC light absorption for moderately-absorbing BrC aerosol (W and Rx).

2CA.12

Secondary Organic Aerosol Formation from Gasoline Vehicle Exhaust Investigated in a Dual Outdoor Chamber System. XUANLIN DU, Jinsheng Zhang, Linhui Tian, Ying-Hsuan Lin, Don Collins, *University of California, Riverside*

Organic aerosol (OA) is a primary contributor to atmospheric fine particles, which cause serious effects on human health, air quality, and climate. Secondary organic aerosol (SOA) contributes the largest fraction of OA in urban areas and is formed from the oxidation of organic vapors. Vehicle emissions are a significant source of SOA precursors. However, the formation mechanisms and chemical composition of SOA from vehicle emissions remain to be fully understood. Furthermore, most studies of SOA from vehicle emissions have utilized a traditional batch chamber in which UV lights are used or an oxidation flow reactor, introducing potential bias due to high oxidant concentrations.

In this study, we employed a complementary approach using a pair of 2-cubic meter outdoor Captive Aerosol Growth and Evolution (CAGE) chambers. The CAGE chambers are operated with entirely or mostly ambient air under natural light conditions, which is more representative of the conditions under which SOA will form in the atmosphere than with indoor UV photo simulations. Idling gasoline vehicle exhaust diluted into ambient air was introduced into one of the chambers (called the perturbation chamber), while the other served as a reference chamber in which the gas composition mirrored ambient air just outside. Significant nucleation and growth of particles were observed in the perturbation chamber, suggesting the important role of vehicle exhaust in new particle formation in the atmosphere. To further understand SOA formation under real-world atmospheric oxidation, the molecular-level composition of secondary aerosol collected on filters was analyzed using a chemical ionization time-of-flight mass spectrometer with a filter inlet for gases and aerosols (FIGAERO-CIMS). The results present a series of special organic particle-phase species formed from vehicle exhaust, which will benefit SOA source apportionment efforts.

2CA.13

Dynamic Optical Properties of Tar Balls during Night-time Aging. SHU-WEN YOU, Prabhav Upadhyay, Joshin Kumar, Ganesh Chelluboyina, Payton Beeler, Joseph V. Puthussery, Benjamin Sumlin, Rajan K. Chakrabarty, *Washington University in St. Louis*

Understanding the carbonaceous aerosols emitted from biomass burning (BB) is of great concern pertaining to their effects on climatic forcing. Tar balls (TBs) are a type of organic carbon generated from low-temperature combustion and contribute to ~30% of BB aerosol mass. With the expected increase in BB emissions due to warmer climates, it is important to understand the interplay between formation mechanisms, physicochemical properties, and optical properties. Few studies have systematically addressed the effects of night-time atmospheric processing on TBs optical properties. In this work, we attempt to elucidate the variation of optical properties during night-time aging under controlled laboratory conditions. The TBs used in this study are generated from low-temperature combustion. Potential aerosol mass oxidation flow reactor (PAM-OFR) is used to investigate the effects of the night-time aging process under different levels of nitrate radical ($NO_3\bullet$) exposures. Integrated-photoacoustic nephelometer (IPN) monitors the absorption and scattering coefficient of TBs across UV, visible, and IR spectrum, providing dynamic optical properties before and after aging processes. Both fresh and $NO_3\bullet$-aged TBs are collected for further characterizations (morphology, internal structure, water/methanol solubility, OC/EC analyses, and volatility). By connecting the physicochemical properties to the optical properties of TBs, we are able to advance our understanding of TBs formation mechanisms as well as their regional/global climate effects.

2CA.14

Predicting Atmospheric Water-soluble Organic Mass Reversibly Partitioned to Aerosol Liquid Water in the Eastern United States. MARWA EL-SAYED, Siddharth Parida, Prashant Shekhar, Amy P. Sullivan, Christopher Hennigan, *Embry-Riddle Aeronautical University*

Water-soluble organic matter (WSOM) formed through aqueous processes contributes substantially to total atmospheric aerosol. The impact of particle drying on fine WSOM was monitored during three consecutive summers in Baltimore, MD (2015, 2016, and 2017). Sample drying induced systematic evaporation of particle-phase WSOM in all three summers and was dependent on relative humidity (RH), WSOM concentrations, isoprene concentrations, and NO_x/isoprene ratios. Two classes of models, namely multivariate polynomial regression, and random forest (RF) machine learning were used to predict the amount of evaporated organic mass using the aforementioned parameters as model inputs. Different models corresponding to each class were fitted (trained and tested) to data from the summers of 2015 and 2016 based on the coefficient of determination (R^2) and the root mean square error (RMSE). Further, model validation was performed using summer 2017 data. An RF model with 100 decision trees had the best performance (R^2 of 0.81) and the lowest normalized mean error. The relative feature importance for this RF model was calculated to be 0.55, 0.2, 0.15, and 0.1 for WSOM concentrations, RH levels, isoprene concentrations, and NO_x/isoprene ratios, respectively. The machine learning model was thus used to predict summertime concentrations of evaporated organics in Yorkville, Georgia, and Centerville, Alabama in 2016 and 2013, respectively. The results presented herein highlight the role of machine learning as a tool to analyze large datasets and elucidate complex atmospheric processes.

2CA.15

Heterogeneous Nitration of Biomass Burning Aromatic Compounds and Evolution of Their Light Absorbing Properties. LAURA-HELENA RIVELLINI, Carolyn Liu-Kang, Jonathan Abbatt, *University of Toronto, Canada*

With climate change, biomass burning (BB) emissions are occurring more frequently as a consequence of hotter and drier conditions. BB is a major source of black carbon and organic aerosols, namely brown carbon (BrC), responsible for light absorption in the ultraviolet (UV) and visible regions. Compounds such as polycyclic aromatic hydrocarbons (PAH), lignin-derived phenols or nitroaromatics are known chromophores and important BrC contributors. In order to reduce uncertainties associated with BB aerosols' impact on climate, it is necessary to improve our understanding of BrC formation and how atmospheric processing affects their chemical and optical properties.

In this work, we focus on the evolution of the light absorbing properties of nitroaromatics formed by heterogeneous nitration of aromatic-containing BB organic aerosols (BBOA) under dark conditions. Flow tube and chamber experiments were conducted to study the reactions between low volatility phenolic compounds, furans and PAHs coated on different seeds (ammonium sulfate, organics and soot) and nitrogen dioxide (NO_2) or nitrate radicals (NO_3). Online and offline mass spectrometry was used for the chemical characterization of BrC upon exposure to NO_2/NO_3, and light absorption properties were monitored online with multiwavelength absorption measurements and offline by UV-visible spectroscopy. Surface reaction experiments of the abovementioned aromatic compounds exposed to various NO_2/NO_3 mixing ratios were also conducted and analysed offline. Finally, heterogeneous nitration of water-soluble extracts and organic aerosols generated by wood burning will also be investigated to simulate conditions closer to night-time aging of BBOA.

2CA.16

Field Measurements of Carbonaceous Aerosol and Secondary Aerosol Tracers for Volatile Methyl Siloxanes in New York City. JOSIE WELKER, Jeewani Meepage, Saeideh Mohammadi, Christopher Brunet, Hanalei Lewine, Rachel Marek, Keri Hornbuckle, Eleanor Browne, Charles Stanier, Elizabeth Stone, *University of Iowa*

Volatile methyl siloxanes (VMS) are known environmental pollutants from personal care products (PCP). In the atmosphere, they are oxidized to form oxidized volatile methyl siloxanes (oVMS) that can partition to form secondary organic aerosol (SOA). This study aims to quantify oVMS in gas and aerosol phases to establish their gas-particle partitioning in ambient air. Fine particle ($PM_{2.5}$) and gas phase samples were collected on the rooftop of the City University of New York Advanced Science and Research Center located in northern Manhattan, New York City from July 7 to August 3, 2022. $PM_{2.5}$ was collected on to precleaned quartz fiber filters and semi-volatile gases were collected onto precleaned polyurethane foam filters (PUF) at a sampling frequency of 12 hours. $PM_{2.5}$ samples were analyzed for elemental carbon (EC) and organic carbon (OC) concentrations using thermal-optical methods. OC concentrations ranged from 2.2 $\mu g/m^3$ – 7.4 $\mu g/m^3$ with a daytime average of 4.7 $\mu g/m^3$ and a nighttime average of 4.5 $\mu g/m^3$, while EC concentrations ranged from 0.16 $\mu g/m^3$ – 0.56 $\mu g/m^3$ with a daytime average of 0.29 $\mu g/m^3$ and a nighttime average of 0.37 $\mu g/m^3$. OC/EC ratios ranged from 5.8 – 27. The higher average daytime OC/EC ratio (17) compared to average nighttime (13) suggests photochemical SOA formation during the daytime. A thermal-desorption gas chromatography mass spectrometry (GCMS) method is being developed to examine tracers of PCP-derived SOA, while solvent extraction GCMS methods will be used to analyze these tracers in the gas phase. This research will inform our understanding of the temporal variation in the magnitude of PCP-derived SOA in ambient air through the gas-particle partitioning of oVMS.

2CA.17

An Algorithm for Evaluating Fractal Parameters of a Single Soot Aggregate. EGOR DEMIDOV, Alexei Khalizov, *New Jersey Institute of Technology*

Soot is a major component of atmospheric aerosols and a potent climate-warming agent. The climate forcing properties of soot change as the particles age in the atmosphere. This change is partly due to morphological compaction of soot particles that occurs upon acquisition of liquid coatings. Freshly formed soot particles are lacey aggregates of complex morphology, which is commonly characterized using fractal theory, as these aggregates have been shown to statistically conform to the fractal scaling law. Accordingly, two parameters, fractal dimension, and pre-exponential factor, are often used to correlate climate-forcing properties of soot to its morphology. Determining the fractal parameters is trivial for an ensemble of aggregates of different sizes, but these parameters cannot be calculated directly in a straightforward manner for a single aggregate. As we are developing a model for soot restructuring, we need to be able to evaluate the fractal parameters of a single aggregate at any step of the compaction process. We hypothesize that since soot aggregates statistically conform to the fractal scaling law, they should be self-similar and we may be able to determine the fractal parameters by extracting sub-aggregates from a single aggregate instead of analyzing an ensemble of individually generated aggregates of different sizes. Preliminary results are promising and we have been able to determine the fractal parameters of aggregates generated numerically with reasonable accuracy. However, more work is needed to optimize the method and formulate its constraints. The algorithm will be verified on both deterministic fractals with well-defined fractal parameters and disordered fractals, such as soot aggregates.

2CA.18

Improving Residential Wood Combustion Emissions Factors and Chemical Speciation with the Reactive Organic Carbon Framework. BENJAMIN MURPHY, Karl Seltzer, Amara Holder, Gabriel Isaacman-VanWertz, Havala Pye, *United States Environmental Protection Agency*

Residential wood burning is one of the largest anthropogenic sources of organic carbon particles and vapors to the atmosphere in the United States, according to recent U.S. EPA National Emission Inventory estimates. The impact of these emissions on air quality is profound, especially in the wintertime when wood is used for heating, and it is expected to grow in relative importance in the future. Existing inventories and photochemical air quality models often use an outdated conceptual model of the phase partitioning of organic particulate and vapor mass. Specifically, regulatory test methods are used to quantify particulate matter emission factors from wood stoves with an operational definition of particulate matter (i.e., mass captured on a Teflon filter) that is susceptible to systematic biases corresponding to the temperature and dilution conditions of each individual test. Meanwhile, total hydrocarbons vapors are characterized using flame-ionization detection, which provides an uncertain measure of gas mixtures containing significant contribution from oxygenated molecules. Finally, the speciation of residential wood burning emissions needs to be revised with state-of-science understanding of key semivolatile and intermediate volatility compounds that are potent secondary organic aerosol precursors.

This presentation discusses the physical basis for and methodology we use to implement revisions to the PM and VOC emission factors and chemical speciation in U.S. EPA emissions modeling tools. Results quantify the impact these updates have on primary and secondary organic aerosol concentrations in the U.S. with the Community Multiscale Air Quality (CMAQ) model employing the new Community Regional Atmospheric Chemistry Multiphase Mechanism (CRACMM). The new approach provides the most rigorous and complete translation to date of organic compound mass from residential wood burning emissions to air pollutant concentrations. Identification of key uncertainties including volatility distributions and OM:OC metrics point to critical areas for future research.

2CA.20

Extracting Soot Morphology from Microscopic Images via Machine Learning. TIMOTHY DAY, Eduardo Carrasco, Khaled Mosharraf Mukut, Somesh Roy, *Marquette University*

Soot or black carbon is the tiny carbonaceous particulate matter that is produced during combustion. As a strong absorber and scatterer of light and radiation, it is one of the major factors in climate change. The actual impact of soot or black carbon on the radiative forcing is influenced by the chemical composition, size, and morphology of soot, and there is a huge variation in composition, morphology, and size in soot particles created from different fuel under different conditions, which leads to considerable uncertainty in our assessment of the impact of soot or black carbon on the climate. Techniques such as transmission electron microscopy (TEM) allow us to capture a detailed image of individual soot particles providing information on their microstructure. Although microscopic images, such as TEM images, contain valuable information, they are essentially a two-dimensional representation of a three-dimensional structure, and therefore, extracting three-dimensional morphological information from the images is not straightforward. In this work, we are exploring possible ways to learn more about soot morphology using computer vision and machine learning on microscopic images of soot. The machine learning model is trained using synthetic soot aggregates. These synthetic soot aggregates are generated from primary particles obtained from our previous molecular dynamics simulation of acetylene pyrolysis, making the training data a good representation of actual real soot aggregates. Finally, the trained model is used on actual TEM images obtained from the literature to test the capabilities of the model.

2CO.1

Shipboard Size Distributions Measurements and Sampling of Aerosol Particles in Ship Plumes at Baltic Sea. DOMINIK SMOK, Jan Hovorka, Pavel Paces, Sandra Pier, Thomas Gröger, Helena Osterholz, *Charles University*

Size distribution measurements and size-segregated sampling of aerosol particles in ship plumes were conducted on board of a working boat while following large cargo ships. Ship plume from large cargo ship characterized aerosol particle distributions of count median diameter at 20 nm and concentration about 10^6 per cubic centimeter at the distance round 50 meters from the ship. Increasing the distance, fast degrease of particle concentration at the CMD indicates their significant coagulation and deposition to sea surface. Self-coagulation can be neglected, since the CMD did not increase during the plume dilution. Therefore, coagulation of 20 nm particles with sea aerosol/droplets could be plausible explanation. Such an assumption would be confirmed by chemical analysis of size segregated aerosol particles.

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2CO.2

Lean-Burn Aircraft Engine Emissions from Burning Sustainable Aviation Fuels: Results from the 2021 and 2022 Boeing ecoDemonstrator Ground Tests.

Richard Moore, Steven Baughcum, Matthew Brown, BENJAMIN A. NAULT, Bruce Anderson, Josh DiGangi, Edward Fortner, Andrew Freedman, Francisco Guzman, Jennifer Klettlinger, Richard Miake-Lye, Kevin Sanchez, Michael Shook, Gregory Smallwood, Elizabeth Wiggins, Edward Winstead, Luke Ziemba, *NASA*

Advancements in technology and fuel sources have led to reductions in the non-volatile and volatile particle emissions from aircraft gas turbine engines. To understand these changes, particle and trace gas emissions were sampled on the ground at 30-60 m behind on-wing engines with lean burn combustors over two years of testing. The 2021 test sampled behind a 737-9 aircraft located at Boeing Field (Seattle, WA, USA), while the 2022 test sampled behind a 787-10 aircraft and a 777-200ER aircraft located at Boeing's Everett Delivery Center (Everett, WA, USA). Four different fuels were investigated, including 100% sustainable aviation fuel (SAF), petroleum-based Jet A fuel, petroleum-based Jet A low sulfur fuel, and a SAF blend.

Volatile and non-volatile particles and trace gases were measured for each fuel and engine combination. Trace gases included CO2, CO, NOx. Total and non-volatile particle number concentration were measured with a pair of condensation particle counters (CPCs), while total and non-volatile particle number size distributions were obtained from a pair of Scanning Mobility Particle Sizers (SMPS). For the non-volatile particle measurements, the CPC and SMPS were operated behind a custom-built thermal denuder heated to 350°C. Non-volatile mass was estimated from particle light absorption techniques from different instruments, and non-volatile and volatile mass in the accumulation mode with a Soot Particle Aerosol Mass Spectrometer. A detailed list of instruments is given on the project websites [1,2].

Overall, the results are consistent with expectations based on the ICAO Emissions Databank for non-volatile particles. Stark reductions in non-volatile particle number and mass were observed for higher thrust conditions when the engine staged. The lowest non-volatile particle emissions were observed for the 100% SAF. Low sulfur fuels were observed to reduce sulfate particle emissions; although, the measured sulfate mass concentrations were always above the ambient background. This paper provides a quantitative assessment of engine emissions indices for lean burn engines burning SAF relative to conventional Jet A.

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This work was supported by the Boeing ecoDemonstrator Program, the NASA Advanced Air Transport Technology (AATT) Project within the Advance Air Vehicles Program (AAVP), and FAA ASCENT Program.

2CO.3

Airborne and Shipboard Measurements of Aerosol Particle Size Distributions in Ship Plumes at Baltic Sea.

JAN HOVORKA, Pavel Paces, Dominik Smok, Sandra Pier, Thomas Gröger, Helena Osterholz, *Charles University*

Ship emissions significantly contribute to global particulate mass. About 15% of the world's cargo traffic occurs at the Baltic Sea. To better predict the fate of plumes there, we evaluate ship plume dispersion at scale of hundred meters from ships.

Aerosol size distributions were measured by a miniaturized scanning electrical mobility sizer positioned at unmanned airship or on board of a working boat. Airborne measurements at heights about 70 m at the distance more than 200 meters from the ship revealed count median diameter of plume aerosol at 65 nm or 120 nm and concentrations reaching 10^5 per cubic centimeter. In contrast, plume aerosol measurements conducted on board of a working boat at the distance about 50 meters and more and at height 1.5 meter above sea surface revealed CMD at 20 nm. Fast coagulation with sea aerosol particles or droplets would be plausible explanation of those nanoparticle absence at higher heights which also suggests their limited transport from the cargo ships.

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2CO.4

Particle Emissions from MPI Gasoline /DPF Diesel passenger Cars during High Speed Operation. HIROYUKI YAMADA, *Tokyo Denki University Graduate School*

To evaluate regulated gases and solid particle number (SPN) emissions in high-load off-cycle conditions, two diesel vehicles with a diesel particulate filter (DPF) and a urea selective catalytic reduction (SCR) system, respectively, and four gasoline port fuel injection (PFI) vehicles were tested with the worldwide light-duty test cycle, including an extra-high (Ex-hi) phase. All the tested vehicles were developed for the Japanese market and did not comply with the Ex-hi phase. All vehicles exhibited higher CO2 emissions in the Ex-hi phase than in low, mid and high phases. Increased NOx and SPN10-23 emissions were observed with the DPF vehicle. These increased emissions were due to the occurrence of passive regeneration of the DPF, and the urea SCR system was stopped as a result. The small gasoline PFI cars showed increased CO and SPN emissions in the Ex-hi phase. These emissions were due to enrichment control which occurred in a quite high load operation condition. The feature of higher emissions with enrichment control differed from that observed in a warming up process in the cold start mode. SPN23 increased mainly in the warming up process, whereas SPN10-23 increased in the Ex-hi phase with enrichment control. Hybrid vehicles seem to have fewer opportunities to show the enrichment control due to motor assist.

2CO.5

Aerosol Emissions and Characterization During the Burning Homes and Structural Materials (BHASMA) Project. JAMIE CAST, Kevin Ridgway, Miranda Trujillo, Cristian Medina, Adam Norris, Thomas Borch, Christian L'Orange, Shantanu Jathar, *Colorado State University*

With nearly 50 million houses in the US located at the wildland-urban interface (WUI) and wildfire frequency and activity on the rise, there is a growing concern that wildfire-related structural fires might be an important source of air pollutants to the atmosphere. However, air pollutant emissions from structural fires are very poorly understood and what we do understand remains fragmented and incomplete. In this poster, we will report on structural fire experiments performed as part of the Burning Homes and Structural MAterials (BHASMA) project at Colorado State University in the Summer of 2023. A total of 75 experiments were performed on 17 different fuels, representing structural wood (e.g., douglas fir), manufactured wood (e.g., oriented strand board), insulation (e.g., extruded polystyrene), carpet (e.g., polyester), roofing (e.g., asphalt shingles), sheathing (e.g., polyvinyl chloride), and fabric (e.g., cotton), under pyrolysis and flaming conditions. Gas and aerosol emissions were measured using a host of online (e.g., 5-gas analyzer, mass spectrometry) and offline techniques (e.g., filters, sorbent tubes) although only a select set of measurements will be presented in this work. We will describe emissions ratios and emissions factors for $PM_{2.5}$, inorganic ions (e.g., sulfate, nitrate), organic aerosol (OA), light-absorbing carbon (e.g., black carbon), and trace metals as a function of fuel and combustion mode. Further, we will contrast emissions for these structural materials against historical data and develop an emission factor database for use in constructing emissions inventories for structural fires. Finally, we will outline ongoing efforts to characterize emissions of hazardous air pollutants that include polycyclic aromatic hydrocarbons (PAHs), organohalogens, and per-and polyfluoroalkyl substances (PFAS).

2CO.6

Evaluation of Emissions from an EMD567 Switcher Locomotive with 100% Soy Methyl Ester Biodiesel. Jeremy Rochussen, Rickey Lee, ANAND KUMAR, Hamed Nikookar, Nadine Borduas-Dedekind, Steven Rogak, Patrick Kirchen, *University of British Columbia*

Engine exhaust is considered a major source of air pollutants which have adverse effects on human health and climate. Biodiesel is drawing attention as a part of solution to meet the demand for renewable transport fuels and to reduce greenhouse gas emissions. However, the effect of biodiesel varies for various exhaust pollutants depending on type of engine, engine speed and load conditions, etc. We investigated the relative change in tank-to-stack emissions from a legacy switching electro-motive diesel engine (Pre-Tier 0, EMD SW900) when fed with: B5 (standard petroleum diesel with up to 5% biodiesel) and B100 (low life-cycle carbon intensity, 100% Soy Methyl Ester biodiesel). This first of its kind field study was conducted in April 2023 at the New Westminster (Canada) yard location of Southern Railway of British Columbia. All tests were performed on a stationary locomotive engine at varying load conditions. Preliminary analysis suggests 51% - 83% lower black carbon emission factor, yet 14% - 26% higher NOx emission factor for B100 with respect to B5. Particulate size distributions show that both fuels generate submicron particles below 300 nm in diameter (mode 50 – 100 nm). Both fuels show similar total number concentrations at low-mid load conditions, but increase to ≈1.5 times for B5 compared to B100 at high load conditions. Interestingly, the number concentrations are at least an order of magnitude (10 – 80 times) lower for both fuels across most loading conditions when the particles are sampled through a catalytic stripper, implying a major contribution of volatile organics. This result also translates into bimodal size distributions with modes observed at ≈15 nm and ≈100 nm. Use of biodiesel as fuel could entail increase of ozone precursors albeit with a reduction in elemental carbon, a global warming agent. Oxidation catalysts could allow for effective control of organic carbon.

2CO.7

Soot-free Emissions from Jet Fuel Combustion: Oxidation Dynamics of Aircraft-like Soot. UNA TRIVANOVIC, Sotiris Pratsinis, *ETH Zurich, Switzerland*

Aircrafts are a significant source of combustion related pollutants which can harm human health and the environment. New restrictions are currently being phased in to limit the permissible number concentrations of non-volatile particulate matter (soot) from aircrafts. So, efficient strategies to meet these increasingly stringent regulations are needed. In this regard, judicious injection of oxygen downstream of aircraft-like soot generators [1] is explored to eliminate soot emissions from spray combustion of jet fuel [2]. Fundamental understanding of the soot oxidation dynamics [3,4] in such a generator is essential for designing and operating aircraft engines to meet competing goals of emission reduction of various pollutants as well as safety and performance. Here, enclosed spray combustion of jet fuel is used to produce aircraft-like soot [1] and a torus ring is used to inject various oxygen concentrations downstream of the spray to remove the soot through oxidation [2]. Using a steel tube with sealable sampling ports for the enclosure allows for a study of the evolution of particles and temperature throughout the soot generator [5]. Injecting oxygen/nitrogen mixtures early on in the flame, at a height above the burner (HAB) = 10 cm, is most efficient at removing soot but does not allow for complete combustion of jet fuel. Late injection (HAB = 50 cm) has little effect on the final soot concentration. Early injection of oxygen/nitrogen increased slightly the OC/TC ratio of soot but had no apparent impact on its nanostructure as quantified by Raman spectroscopy. At HAB = 30 cm, most soot particles were removed by oxidation while still allowing for complete hydrocarbon combustion. At HAB = 35 cm, just after oxygen/nitrogen injection, soot number concentrations were drastically reduced with slightly higher concentrations near the tube wall than at its centerline. Concentrations continued to decrease downstream till the exit of the burner. Temperatures were measured along the centerline of the flame and radially, 1 cm from the wall and ranged from about 300 to 1050 C.

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2CO.8

The Influence of Smoke Particle Properties and Cabin Characteristics on Smoke Detection in Lunar Gravity.

CLAIRE FORTENBERRY, Ramaswamy Balasubramaniam, David Urban, *NASA Glenn Research Center*

Spacecraft fires pose a threat to the success of future Lunar, Martian, and deep space exploration missions. As NASA plans to return humans to the Moon in the next decade, novel mission requirements will present new fire safety challenges. For example, materials that are fire resistant on Earth are expected to burn under planned habitat conditions (elevated oxygen concentrations and reduced cabin pressure) and partial gravity (0.16g). Optimal smoke detector placement will depend on a combination of buoyant plume velocities, induced by partial gravity, and Environmental Control and Life Support Systems (ECLSS) parameters, including particle filtration rates, supply and return placement within the cabin, and forced air velocities. These ECLSS parameters must also address the need for rapid Lunar dust removal, as Lunar dust exposure poses a risk to crew health and hardware functionality.

Here, we present progress toward a computational fluid dynamics model to evaluate smoke transport in a Lunar habitat. Recent work has demonstrated that if air supplies are placed on ceilings and returns on the floor, a buoyant smoke layer at the ceiling may disperse over the order of minutes even under low forced flow conditions. We expand upon these results to examine the influence of different supply and return configurations on smoke plume development. Additionally, we also address differences in the transport of smoke particles and Lunar dust by varying particle parameters like size, density, and shape factor. Finally, we discuss ongoing and future experimental efforts to measure smoke particle properties and transport under partial gravity, elevated oxygen, and reduced pressure conditions.

2DI.3

Community-Scale Monitoring of Particle-Bound Metals in Two Environmental Justice (EJ) Communities in the South Coast Air Basin: II. Stationary Monitoring Results.

CHRISTOPHER LIM, Mohammad Sowlat, Julia Montoya-Aguilera, Steven Boddeker, Ethan Balagopalan, Bill Grant, Eric Holden, Sina Hasheminassab, Payam Pakbin, Andrea Polidori, Jason Low, *South Coast Air Quality Management District*

Literature on the community-scale, spatio-temporal variability in ambient concentrations of particulate metals, many of which are known toxic air contaminants (TACs), is scarce. This scarcity is more highlighted in Environmental Justice (EJ) community, where residential areas and sensitive receptors are intermixed with urban sources. South Coast Air Basin (SCAB) is home to many EJ communities, including the East Los Angeles and Southeast Los Angeles. Both of these communities have been designated by California Air Resources Board (CARB) to be part of the Assembly Bill (AB) 617, a state-wide program that aims to reduce the impact of air pollution in EJ communities. East Los Angeles and Southeast Los Angeles communities are home to metal-processing facilities that are known sources of particulate metals. Residents in these communities have concerns about potential exposure to emissions of particle-bound metals from these facilities. To address this air quality concern, a year-long air monitoring campaign was conducted, comprising stationary as well as near-source, hyperlocal mobile monitoring of multi-metals. In this presentation, results on the temporal (i.e., diurnal, day-of-the-week, seasonal) trends of particle-bound metals measured at two monitoring stations in the East and Southeast Los Angeles communities will be provided. This overview provides information on how the analysis of the data allows for inferences on the sources of particle-bound metals in the target communities. In an accompanying presentation, results from the mobile monitoring surveys conducted in these two communities will be discussed.

2DI.4

Climate Penalty on Air Pollution Mitigated by Anthropogenic Emission Reductions in the United States. LIFEI YIN, Qiao Zhu, Bin Bai, Bingqing Zhang, Qian Di, Weeberb Requia, Loretta Mickley, Joel Schwartz, Liuhua Shi, Pengfei Liu, *Georgia Institute of Technology*

Climate change is one of the greatest global challenges in the 21st century, exerting adverse impacts on human health. Previous studies have proposed numerous pathways for the health impact of climate change and have evaluated the health burden associated with rising temperature. One potential pathway is through interactions with air pollution, as a rising temperature can worsen air quality even in the absence of changes in anthropogenic activities, known as the “climate penalty” on air quality. However, how a warmer temperature deteriorates air quality remains highly uncertain in the United States, particularly under rapid reduction in anthropogenic emissions in recent decades. Here we examined the sensitivity of surface-level fine particulate matter ($PM_{2.5}$) and ozone (O_3) to summer temperature anomalies in the contiguous US and their decadal changes using high-resolution datasets generated by machine learning models. The machine learning datasets successfully reproduced the temperature sensitivities of $PM_{2.5}$ and O_3 observed at ground stations and provided a more representative regional sensitivity by completing the picture for areas without stations. Our findings demonstrate that, in the eastern US, efficient emission control strategies have largely reduced the climate penalty effects on $PM_{2.5}$ and O_3, lowering the population exposure and associated health risks. In contrast, summer and annual $PM_{2.5}$ in the western US have become more sensitive to summer temperature, highlighting the urgent need for the management and mitigation of worsening wildfires. The generated high-resolution data of temperature sensitivity of $PM_{2.5}$ and O_3 are helpful in evaluating the performance of chemistry transport models in capturing the response of air pollution to climate change. The evolution of temperature sensitivity of air pollutants with emission changes indicates that factors controlling air quality are not independent. The interactions should be considered when using models to predict future air quality.

2DI.5

OpenAQ: Providing Universal Access to Air Quality Data to Empower a Global Community of Changemakers in Solving Air Inequality. COLLEEN MARCIEL ROSALES, Chris Hagerbaumer, Russ Biggs, Gabriel Fosse, *OpenAQ*

OpenAQ is an environmental tech nonprofit that aggregates and harmonizes open ambient air quality data from across the globe onto a free, open-source data platform so that anyone concerned about air quality has unfettered access to the data they need to analyze, communicate and advocate for clean air. By providing universal access to air quality data, OpenAQ empowers a global community of changemakers to solve air inequality–the unequal access to clean air.

OpenAQ was the first to aggregate disparate ground-level ambient air quality data, including particulate matter, on a centralized open-source platform, making it findable, accessible, interoperable and reusable. By providing this foundational data infrastructure for free, we fill a basic data-access gap and make it possible for individuals and organizations to fully maximize the uses–and ultimate impact–of ground air quality data, bringing global networks of ground-based ambient monitors onto one platform. We also developed tools to connect users of this data across sectors and geographies to support an international learning environment. In this talk, we’ll be presenting developments on the platform, initiatives and use cases for the data in OpenAQ, and ways that OpenAQ has supported data hosting and management for air quality data in low- and middle-income countries.

2DI.6

Racial Disparities in Fine Particulate Matter Exposure and COVID-19 Spread in the United States.

PAYTON BEELER, Rajan K. Chakrabarty, *Washington University in St. Louis*

Minority populations across the United States (US) have been disproportionately affected by 2020 COVID-19 pandemic. However, the underlying reasons for the rapidity of disease spread in minority communities are not clear. Here, we investigate the relative impact of county-level disparities in 28 factors on the basic reproduction ratio (R_0) of COVID-19 in twelve major metropolitan statistical areas (MSAs) in the US. On average, we find that a 10% increase in long-term, ambient $PM_{2.5}$ exposure (particulate matter with aerodynamic diameter 2.5 µm or less) is associated with a 7.6% increase in R_0, an outsized effect in comparison to other factors. In addition, we find that the largest disparities in $PM_{2.5}$ exposure and R_0 are concentrated among Hispanic-American communities, followed by Asian-American and African-American communities, highlighting the effects of longstanding geographic segregation of minority communities. We conclude by providing each MSA with a roadmap for identifying which communities should be targeted for $PM_{2.5}$ mitigation policy implementation.

2DI.7

Pressurization and HVAC Configuration of Hospital Operating Rooms with an Airborne Disease Infected Patient.

REZA DANESHAZARIAN, Jeffrey Siegel, *University of Toronto*

Surgical-site infections (SSIs) are a major concern in the field of surgery, and various factors need to be considered in order to reduce their occurrence, including pressurization, air exchange rate, and the presence of an anteroom. Hospital operating rooms (ORs) are typically maintained at positive pressure, and the addition of an anteroom can help to prevent the transmission of airborne infectious diseases. The anteroom is kept at a lower pressure than the OR to act as a barrier against contamination from the OR. In response to the emergence of SARS-CoV-2 in 2020, temporary anterooms were sometimes used to reduce the risk of transmission. The objective of the current study is to design an optimal OR ventilation system that reduces the transmission of airborne infectious diseases. To achieve this goal, a wide range of monitoring systems were deployed to characterize the size distributions and spatial variations in concentrations of particles in the OR. Sensors and monitors were placed at different heights to account for the location of the operating table and healthcare workers. Air properties such as temperature, relative humidity, air velocity, and pressure were measured at every step of the process. Artificial saliva was prepared and characterized to simulate human saliva (pH=6.78). Aerosol solution was released from a nebulizer positioned at the patient's head (lying horizontally on the operating table) to simulate continuous breathing aerosol, and a cough box was constructed to study sudden particle generation during OR procedures such as extubating. Computational fluid dynamics (CFD) and experimental results showed that the presence of an anteroom can reduce ventilation contamination and prevent the migration of particles from the OR into clean corridors. The results also confirmed that the type of air ventilation has a significant impact on particle transmission, and the use of mixed turbulent airflow can increase contamination.

2DI.8

Towards the Real-Time Detection of Hazardous Dust from Narcotics and Explosives. JOHANNES PASSIG, Andreas Walte, Sven Ehlert, Guanzhong Wang, Heinrich Ruser, Ellen-Iva Rosewig, Julian Schade, Aleksandrs Kalamašhņikovs, Robert Irsig, Petra Hehet, Michael Pütz, Martin Seipenbusch, Simone Vinati, Karsten Wegner, Konrad Matena, Thorsten Streibel, Ralf Zimmermann, *Rostock University and Photonion GmbH*

Hazardous dusts pose substantial risks for human health and security. This applies not only to air pollution, e.g from combustion processes, but also to releases of hazardous substances after accidents or during illicit transport and handling of drugs and explosives. The current opioid crisis in the U.S. shed new light on the lack of technologies that can detect such dusts from narcotics in real time, e.g. to protect staff in parcel logistics, at airports or custom offices as well as to support criminal investigations. In the HazarDust project, we are developing technologies to close this gap, in a collaboration of SMEs, academic partners and authorities.

The core detection technology of our approach is single-particle mass spectrometry (SPMS), which is capable to chemically characterize individual particles in a complex aerosol (Pratt and Prather, 2012). After having introduced resonant ionization methods for particle-bound metals (Passig et al. 2020) and polycyclic aromatic hydrocarbons (Passig et al. 2022), we are ready to tailor the SPMS technology to dusts of various narcotics and explosives. We present the resulting single-particle mass spectral signatures of over-the-counter medicals, precursors of fentanyl and other drugs and show how to overcome interferences with other particle types in a complex environment. While SPMS are real-time instruments, the complex data evaluation is generally performed offline, after the measurement procedure is finished (Sultana et al., 2017). This disables on-line screening of hazardous particles and real-time risk assessment. To overcome this severe limitation, we are developing real-time software including data acquisition, preprocessing, screening and clustering. A strong emphasis is put on machine learning algorithms using open-source databases. We investigated supervised learning approaches for particle screening and classification and show that they can greatly outperform the traditional unsupervised algorithms like ART-2a clustering in terms of speed and accuracy of detecting a large variety of particle classes, facilitating real-time data analysis and immediate emergency response (Wang et al., 2023).

Beyond SPMS, we show first results from particle re-dispersion experiments with gas pulses and aerosol enrichment for direct sampling of dust residues from surfaces of luggage and parcels.

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2DI.9

Detection and Classification of Super-Micron Urban Aerosols with Open-Path Digital Holography. NICHOLAS GOOD, Matt Freer, Gavin McMeeking, Benjamin Swanson, Matthew Berg, *CloudSci LLC*

Super-micron aerosols are an important component of urban air that have impacts on human health and climate. They vary significantly over space and time, more so than accumulation mode particles, due to their wide range of sources and short atmospheric lifetimes. Urban environments face major challenges in adapting to a changing climate and will require better information regarding sources of air contaminants resulting from greening and electrification efforts, which will likely replace combustion sources over time. There are few instruments suitable for measuring super-micron particle properties such as size, shape, and abundance, rapidly and over the large spatial and temporal scales needed. An additional challenge is the difficulty of sampling large particles through instrument inlets without losses or other measurement artifacts. To meet these needs, we are developing a novel, lower-cost sensor based on digital inline holography. It features an open path design and novel triggering system, eliminating inlet artifacts. We present results from laboratory experiments in a custom-built wind tunnel capable of generating aerosols and propelling them through the holography apparatus at a range of velocities expected in urban environments. The new sensor is evaluated against an aerodynamic particle sizer and microscopy analysis of filter samples. Particles evaluated include glass bead size standards, non-spherical particle standards, common allergens such as pollen and dust mites, and road dust. Initial field measurements in two urban locations are also presented.

2DI.11

Leveraging Explainable Machine Learning to Understand the Impacts of Meteorology on PM2.5 Sources during a Household Energy Transition in China. COLLIN BREHMER, Christopher Barrington-Leigh, Jill Baumgartner, Sam Harper, Martha Lee, Xiaoying Li, Guofeng Shen, Talia Sternbach, Shu Tao, Xiang Zhang, Yuanxun Zhang, Ellison Carter, *Colorado State University*

Quantifying the impacts of energy and environmental policies on fine particulate matter ($PM_{2.5}$) air pollution is challenging due to multiple contributing sources and non-policy related factors like meteorology. Variations in meteorology over time could mask the impacts of an air pollution policy on the specific source it is targeting. Accounting for time-varying meteorological impacts on PM and its sources is critical for evaluating the impacts of an air pollution policy but has been difficult to incorporate in field-based impact evaluations of air pollution policies, which themselves are scarce. We collected outdoor and personal exposure PM2.5 measurements in 50 villages in rural Beijing across three winter seasons (2018-2022). Samples were analyzed for elemental concentrations and water-soluble ions. Source apportionment by Positive Matrix Factorization identified common sources in outdoor and personal exposure samples as nitrite, secondary ions, dust, transported dust, coal combustion, construction dust (outdoor only), and biomass combustion (personal exposure only). Our goal was to determine which sources were impacted by meteorology and which meteorological variables had the highest impact. Random forest models predicted source contributions using temperature, wind speed, boundary layer height, and relative humidity. The sources with the highest cross-validated predictability were dust for outdoor samples and secondary ions for outdoor and personal exposure samples (CV r^2: 0.31-0.40). We used variable importance plots to determine the meteorological variables driving changes in $PM_{2.5}$ sources (relative humidity) and partial dependence plots to determine how they are driving changes in sources (positive relationship with secondary ions). By comparing source concentrations and meteorology across years we found higher $PM_{2.5}$ in winter 2019-2020 due to increased secondary ion concentrations related to higher relative humidity. These findings enhance our understanding of how $PM_{2.5}$ concentrations change over time in relation to meteorology, providing insights into the real-world effectiveness of air pollution policies.

2DI.12

Development of a New Health Metric for Fine Particles Based on Differential Toxicity. JINGYU LEE, Minhan Park, Kihong Park, *Gwangju Institute of Science and Technology*

As the health hazards of fine particulate matter (PM2.5) have become a prominent issue, research has been conducted to develop quantifiable indicators to assess its impact. However, the PM2.5 mass concentration fails to consider the variability in toxicity of PM2.5 based on its chemical composition. The oxidative potential (OP) lacks direct correlations with the health impacts of PM2.5. The risk of PM2.5 risk should consider both toxicity and exposure. Therefore, health metrics that can reflect the chemical composition of PM2.5 and differential toxicity, as well as the level of exposure of PM2.5.

In this study, the toxicity score considered the relationship between chemical composition of PM2.5 from emission sources and toxicity. To calculate the toxicity score, toxicity data (Oxidative stress, cytotoxicity, DNA damage, inflammation, and OP) of engine exhaust particles (diesel and gasoline), biomass burning particles (pine stem and rice straw), coal combustion particles, and cooking particles used.

Previous research about considering exposure of PM2.5 considered toxicity of PM2.5 indirectly. To avoid this problem, all PM2.5 mass concentration data was combined. Exposure score was calculated based on the PM2.5 mass concentration using various regression models. The exposure score was assigned a value of 0 for a mass concentration of 0, a value of 5 for the average PM2.5 mass concentration, and a value of 10 for the maximum PM2.5 mass concentration.

The new health metric was applied to the ambient PM2.5 data collected from Beijing and Gwangju site during the winter of 2018, summer and winter of 2019, and winter of 2020. Additionally, data collected in Gimje site during the summer of 2020, winter of 2021, (livestock agricultural site) and summer of 2021 (crop agricultural site) were also included in the analysis.

2DI.14

Indoor Air Quality and Ventilation Patterns in Diverse Occupational Facilities across Colorado, and Outdoor Pollution Effects. BENJAMIN SWANSON, Rachel Stevens, Will Clagett, Nicholas Good, Gavin McMeeking, Kate Patterson, Kathy Boyer, Odessa Gomez, Kristen Good, Ellison Carter, *Colorado State University*

Workplaces significantly influence public health due to the considerable time people spend there. Our study fills the knowledge gap on pollutant infiltration in occupational spaces, focusing on the relationship between indoor and outdoor particulate matter (PM). We examined indoor air quality (IAQ) and ventilation systems in 28 diverse facilities across Colorado, in partnership with the Colorado Department of Public Health and Environment.

We measured IAQ parameters, including CO_2, NO_2, NO, O_3, $PM_{1}/_{2.5}/_{10}$, $PN_{1}/_{2.5}/_{10}$, and TVOCs, underscoring the complexity of indoor air pollution. Our key focus was the differences between indoor and outdoor fine PM levels, known to pose significant health risks. We evaluated indoor and outdoor PM at all workplaces, identifying factors influencing indoor PM exposure.

Our findings revealed significant differences in the correlations between indoor and outdoor PM levels (Spearman correlations from 0.23 to 0.96). No strong trend was observed between workplace-averaged ratios of indoor to outdoor PM concentrations and their pairwise correlation coefficients. However, in workplaces where indoor PM concentration was >90% of outdoor concentration, a negative trend was observed (Slope = -7.1; R2 = 0.69), suggesting less infiltration and more internal PM generation.

Our study provides insights into the IAQ profiles of diverse workplaces, aiding in the enhancement of IAQ management strategies. Given the variety of facilities and their locations in Colorado, our findings should inform local and regional air quality policies.

2HA.1

A Novel Approach for Measuring Deposition Characteristics of Nebulized Droplets using a Realistic Mouth-Throat Airway Model. Hao Xu, Huizhen Yang, XIAOLE CHEN, Ya Zhang, Yu Feng, *Nanjing Normal University*

Deposition experiments were conducted to investigate the behavior of nebulized droplets in a realistic mouth-throat airway model. The droplets were generated using a customized vibrating mesh nebulizer. The median mass aerodynamic diameter (MMAD) and geometric standard deviation (GSD) of the nebulized droplets were measured as 5.019 µm and 1.495, respectively. The droplet solution consisted of fluorescent normal saline. The mouth-throat airway model was reconstructed based on a CT scan of a healthy 46-year-old male. The deposition characteristics of the nebulized droplets, including deposition fractions and patterns, were examined under five different inhalation flow rate conditions.

The deposition fraction decreased from 27.06% at 15 L/min to 17.91% at 22.5 L/min, and then gradually increased to 33.85%, 42.03%, and 61.92% at flow rates of 30, 45, and 60 L/min, respectively. These findings generally align with our previous experiments using an idealized mouth-throat model (Yang et al., 2023). However, the deposition fractions observed in our study were higher than those reported in the idealized mouth-throat model proposed by Zhang et al. (2006).

As the flow rate increased, the deposition pattern of the fluorescent droplets demonstrated a gradual transition from the oral cavity to the posterior region of the oropharynx. Our novel method enabled quantitative determination of the deposition fraction and qualitative visualization of the droplet deposition pattern in a single experiment.

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2HA.2

Exposure Studies of Living Organisms: How the PolluRisk Platform is Simulating at the Laboratory Urban Air Quality and its Health Impacts. PATRICE COLL, Antonin Bergé, Elie Al Marj, Mathieu Cazaunau, Aline Gratien, Lucy Gerard, Bénédicte Picquet-Varrault, Spyros N. Pandis, Sophie Lanone, The PolluRisk Team, *LISA UMR CNRS 7583, France*

It has been widely accepted that there are clear relations between exposure to atmospheric pollution and Health impacts (epidemiology and toxicology studies). This explicit demonstration has been supported – as an illustration - regarding mortality and morbidity effects of long-term exposure to low-level PM2.5, BC, NO_2 and O_3 (*analysis of European cohorts in the Elapse project*).

We have developed the PolluRisk platform, that reproduces for days the atmospheric phases (gases/aerosols) similar those of cities like Paris or Beijing. It is mainly resulting from the coupling of an atmospheric simulation chamber (cesam.cnrs.fr) and of exposure devices able to host preclinical models (isolators from Noroit® company). The principle of such an atmospheric simulation is described on the platform website : pollurisk.eu

The experimental protocol consists in the continuous injection of primary pollutants (NOx, COVs mix, SO_2, soot, inorganic salts and potentially mineral dust particles if needed) low concentrations (ppb levels) in air in the chamber. With a 4 hours residence time in the chamber, the mixture is exposed to an artificial solar irradiation, allowing secondary pollutants such as O_3, NO_2, HCHO, etc. as well as complex polyfunctional organics including Secondary Organic Aerosol (SOA) to be formed, reaching a chemical steady state. Isolators are then “fed” with a constant flow of such a mixture. The “reference” isolator is filled up with filtered air only.

We will illustrate the results regarding 2 experiments (one simulating a summer Paris atmosphere and one simulating a winter Paris atmosphere, both for a duration of 7 days). We will present 1/ the SOA characterization including Organics, Nitrate or Sulfate content 2/ the functionalized particulate compounds observed 3/ some biological characterizations of the exposed mice lungs. These results clearly state the interest of Atmospheric Simulation chambers to support such exposure studies devoted to Health Impacts of Air Quality.

2HA.3

Gaseous Pollutants Linked to Pulmonary Diseases: East Meets West. FATIM SANNOH, Haider Khwaja, Zafar Fatmi, Nadeem Rizvi, Aftab Turabi, Mirza M. Hussain, Azhar Siddique, David Carpenter, *University at Albany*

Air pollution is one of the most prominent global threat to public health. Pakistan is ranked among the top five Asian countries. There is insufficient information about the impacts of gaseous pollutants (O3, NO, NO2, HNO3 and SO2) due to economic limitations and lack of adequate measuring facilities in urban centers of Pakistan. It is essential to understand the health effects of gaseous pollutants to implement effective air pollution regulatory programs. This is the first study to evaluate the morbidity risk for pulmonary diseases, associated with gaseous pollutants exposure in Karachi, Pakistan. The total number of gaseous pollutants samples collected was 400 (approximately 100 during each of the four seasons) with simultaneous hospital data collection. Results indicated a strong association between O3 exposure and asthma, tuberculosis, shortness of breath (SOB), and total pulmonary disease in both sexes. In males, SO2 exposure was associated with SOB. COPD was linked with HNO3 exposure among males compared to females, while association was found between NO/NO2 exposure with asthma in males only. Association was found to exist between gaseous pollutants exposure and pulmonary diseases in both age groups, with the greatest association found among patients ages 0 – 50. The findings are mainly in agreement with the reported studies. Overall, low statistically significant estimates suggest that while gaseous pollutants (NO, NO2, O3, HNO3, and SO2) may be a valuable indicator for pulmonary health risks from industrial and combustion-derived particles, further assessment of these pollutants and their relative contributions to pulmonary health impacts in Karachi is necessary to provide much-needed data and relevant information to clinicians, researchers, health policy and policymakers in designing programs and plans of actions to address air pollution-related health effects in Pakistan.

2HA.5

Dynamic Chemistry of Passive Vaping Aerosols in the Indoor Environment. ALEXA CANCHOLA, Ying-Hsuan Lin, *University of California, Riverside*

As e-cigarette usage continues to rise in popularity, passive vaping – inhalation of aerosols exhaled by an active user or contact with aerosols deposited on surfaces – remains a pressing public health concern. Research indicates that inhalation of e-cigarette exhalate may result in exposure to high concentrations of reactive carbonyl species, which may promote oxidative damage in biological systems. Furthermore, exhaled aerosols may linger in the air which increases the possibility of aging – especially in polluted regions with high levels of indoor oxidants such as ozone (O_3). This process may greatly affect the chemical properties of aerosols, potentially altering their toxicity upon exposure. While a great deal of research has focused on the characterization of active e-cigarette emissions, there is a gap in understanding of how interactions between e-cigarette aerosols and atmospheric oxidants may alter their physiochemical properties and the risk of oxidative damage upon exposure to non-users. To address this, we monitored the chemical composition and the presence of carbonyl-containing species in fresh and O_3-aged nicotine e-cigarette emissions using a combination of offline and online mass spectrometry approaches in a controlled environmental chamber. In addition, the real-time size distribution of the aging e-cigarette emissions were monitored using a scanning electrical mobility spectrometer (SEMS). We have found that when vaping emissions produced from disposable nicotine e-cigarettes are reacted with O_3, there is a clear shift in chemical composition, with increased production of carbonyl-containing species such as formaldehyde, acetaldehyde, pent-1-en-3-one, and methylglyoxal. The results of this study indicate that bystanders exposed to e-cigarette exhalate may be exposed to highly oxygenated compounds that may increase the risk of downstream respiratory diseases. Ultimately, our results provide important information that will help advance our understanding of the impact of e-cigarettes on indoor air quality.

2HA.6

Evaluating Silicone Wristbands for Personal Passive Sampling of Cyanobacteria Toxins: Evidence from the Diversity and Innovation in Screening and Prevention of Exposure over the Long-term (DISPEL) to Harmful Algal Blooms Study. RAQUEL CHENAIL, James Christie, Cassandra Gaston, Alberto Caban-Martinez, Kimberly Popendorf, *University of Miami*

Harmful algal blooms (HABS) are increasing in frequency and severity due to climate change and land use changes. HABS are known to produce toxins that can negatively impact human health through ingestion, dermal contact, and inhalation. Many Florida communities are at risk of HAB exposure including fishermen, researchers, and lakeside residents as they interact with HAB laden water and aerosols. One of the most impactful toxins in freshwater HABs, microcystin, can lead to health impacts such as dermal and respiratory irritation. While current methods exist to monitor these algal blooms, they often require sampling devices that are not user friendly, preventing mass deployment of monitoring devices. To create a more user friendly and equitable monitoring device, we tested silicone wristbands for the first time to determine their ability to capture aerosolized microcystin. We tested this by generating microcystin aerosols using a bubbler apparatus to simulate lake spray, where the silicone wristbands and subsequent filters were exposed to determine if silicone wristbands could capture microcystin aerosols. Alongside testing wristbands with different concentrations of HAB filled waters, we also tested a sample which was immersed in water containing microcystin to determine if non-aerosolized microcystin could stick to the wristbands. To determine the concentration of microcystin on each wristband, as well as the filters, we analyzed the extract using a high-pressure liquid chromatography triple quadrupole mass spectrometer (HPLC-MS). By comparing our wristband and filter extracts to a procedural blank, we were able to determine the concentration of the nine known congeners of microcystin deposited on our wristbands and compare them to the concentrations of microcystin deposited on the filters. From this work, we are able to provide a cost-effective and user-friendly aerosolized HAB monitoring device, which can be further developed to determine HAB exposure levels for residents, scientists, and fishermen.

2HA.7

Vaping-Induced Transformation of Terpene Additives in Cannabis Vape Products and its Impacts on the Cell Membrane Integrity. SIRI LANGMO, Alexa Canchola, Ruth Meletz, Ying-Hsuan Lin, *University of California, Riverside*

Terpenes are a class of compounds commonly used as flavoring agents and diluents in commercial e-liquids and have been found in recent research to undergo chemical transformation during vaping, resulting in the formation of potentially harmful compounds. However, despite their widespread use, little research has focused on terpene transformation during vaping or their impact on the cell membranes of human epithelial cells. To address this, medium-chain triglyceride (MCT) oil were vaped with and without select terpenes added (93:7 ratio). Resulting aerosols were analyzed using gas chromatography/mass spectrometry. BEAS-2B cells were exposed to the vaping emissions and the cell membrane integrity was assessed using the Lactate Dehydrogenase (LDH) assay. Results found that all selected terpenes transformed into highly oxidized products during the vaping (e.g., limonene oxide and α-pinene oxide). In addition, it was found that degradation of the carrier oil, MCT, was enhanced when terpenes were present, forming fatty, acid-like products. When exposed to lung epithelial cells, emissions generated in the presence of terpenes resulted in increased LDH levels compared to MCT oil alone, indicating decreased membrane integrity when exposed to MCT+terpene vaping emissions. Our results indicate that terpene oxidation may result in the formation of products with biosurfactant-like characteristics that may damage cellular membranes. The results of this study show the oxidation products of terpenes, formed during vaping, increase membrane permeability and are a stepping stone to understanding the cytotoxic effects of terpenes in vaping products.

2HA.8

Development of an Advanced Personal Nasal Sampler (PNS) to Assess Personal Exposures to Infectious Agents. TAEWON HAN, Gediminas Mainelis, *Rutgers, The State University of New Jersey*

This research focuses on developing a novel personal nasal sampler (PNS) capable of measuring actual personal exposure to airborne infectious agents, including individual viruses, virus-laden droplets, as well as virus-particle agglomerates, thus reducing respiratory health risks. The sampler attaches to a user's nostrils. It utilizes the person's own breathing to capture airborne infectious agents on an advanced filter, thereby directly measuring actual personal exposure to those agents. Here we report on the development of PNS. In the first step, we focused on developing a novel, low-pressure hybrid filter (HF) by coating various conventional non-woven microfiber base substrates with a thin coat of electrospun nanofibers. Several base substrates (e.g., spunbond or meltblown fabric filter, nylon mesh screen, MERV 5 or 6 carbon filter) were selected and then coated with polyvinylidene fluoride (PVDF or P(VDF-TrFE) polymer nanofibers using electrospinning at (+)20 kV voltage. The performance of the newly created hybrid filters (HF) was investigated by challenging them with polydisperse NaCl particles (aerosolized 1% suspension) or Arizona road dust particles drawn through the filter at 10-15 L/min (i.e., 1.7-2.5 m/s face velocity). The collection efficiency of each produced HF (0.5 inches in diameter) was determined by comparing particle number concentration upstream and downstream of the HF using a MiniWRAS (Grimm Aerosol Technik, Ainring, Germany). The pressure drop was measured across each filter was also measured. The HF based on the MERV 5 carbon filter showed a collection efficiency of approximately 60% for a broad range of particle sizes (10 nm to 5 µm), and the pressure drop was about 100 Pa. In the next step, we will fabricate a filter holder to design PNS, and then the PNS will be installed in a mannequin and operated in different environments.

Keywords: Personal exposure; nasal filter; electrospinning; airborne viruses

2HA.9

Co-Localization of Influenza Virus and Mucin in Droplets on Surfaces. JIN PAN, Nicole C. Rockey, Seema Lakdawala, Nisha Duggal, Linsey Marr, *Virginia Tech*

The inactivation of influenza virus or other respiratory viruses in droplets and aerosols depends on their chemical composition, among other factors. To investigate how interactions between virions and proteins impact the viability of virus in droplets, we visualized the localization of influenza virus and mucin, a glycoprotein that is present in saliva and airway surface liquid, by fluorescently labeling the virions and proteins, exposing them to varying levels of relative humidity, and imaging them. During evaporation, virions and mucin are driven to the outer edge of the drying droplets by Marangoni flow, resulting in co-localization of virions and mucin and the “coffee-ring” effect. This effect was more prominent when the drying droplet was closer to the point of phase change, i.e., the transition from the semi-solid phase to the solid phase. This finding suggested that the coffee-ring pattern might enhance the protective effect of mucin on virions by concentrating them to form aggregates.

2HA.10

Effects of Ozone-Mediated Aging on the Oxidative Potential of E-cigarette Aerosols. WONSIK WOO, Alexa Canchola, Michael Lum, Linhui Tian, Ying-Hsuan Lin, *University of California, Riverside*

The production of e-cigarette aerosols is known to cause the formation of various free radicals and reactive oxygen species (ROS). The oxidative potential and cytotoxicity of fresh e-cigarette aerosols are well-characterized, with previous work showing that the presence of transition metals and oxygen during the formation of e-cigarette aerosols produces the highly reactive OH radical. However, the effects of chemical aging by ambient oxidants in the indoor environment are yet to be elucidated. This brings forward the question of whether the oxidation of organic compounds found in e-cigarette aerosols will lead to a greater formation of ROS and what implications it would have on the health of bystanders. In this study, we aim to determine the effects of ozone on modifying the chemical composition and toxicity of e-cigarette aerosols. E-liquid mixtures will be aerosolized into a 10 m3 Teflon chamber, and the generated aerosols will be subjected to various concentrations of ozone for an hour. The newly formed secondary organic aerosols (SOA), along with fresh aerosols, will be collected to detect the presence of ROS and for cell exposures to determine cytotoxicity. The presence of radical species will be determined by electron paramagnetic resonance (EPR) spin-trapping, and their relative abundance will be quantified with the DCFH2DA assay. Cell exposures to various concentrations of fresh e-cigarette aerosols and their SOAs, along with a lactate dehydrogenase (LDH) assay, will be used to measure relative cytotoxicity. Through the aging process, we expect to see a greater amount of ROS formation in chemically aged e-cigarette aerosols than that found in fresh e-cigarette aerosols. Given that the toxicological characteristics of e-cigarettes are mainly associated with the inhalation of fresh aerosols in current studies, our work may provide a perspective that characterizes second- and third-hand vaping exposure as a significant health risk.

2HA.11

A Real-World Approach to In-Vitro Lung Epithelial Cell Toxicology of Atmospheric Air Pollutants. CYNTHIA PHAM, Ryan Huff, Davi de Ferreyro Monticelli, Chris Carlsten, Naomi Zimmerman, *University of British Columbia*

Exposure to atmospheric air pollution is a major global health risk. However, our understanding of the toxicological effects of air pollution is generally limited to controlled laboratory experiments that do not truly represent the ambient air we breathe where complex reactions and mixtures exist. To close the knowledge gap, we deployed a cell air-liquid-interface exposure instrument (Cultex-RFS) in a mobile laboratory (Portable Laboratory for Understanding human-Made Emissions, PLUME Van) using human lung epithelial cells to determine the direct effects of the inhalation of ambient air pollution, focusing on the Greater Vancouver area in British Columbia, Canada. The cell exposure instrument is coupled with real-time analytical instruments such as standard gas analyzers (CO, NOx, O3; Teledyne T300U and 2B Technologies Models 714 and 205), a VOC analyzer (SRI 8610C GC-FID), and particle sizers and counters covering the inhalable particulate matter size range (fast mobility particle sizer (FMPS, TSI 3091), water condensation particle counter (WCPC, TSI 3789), optical particle sizer (OPS, TSI 3330)), along with offline chemical composition analysis using inductively coupled plasma mass spectrometry (ICP-MS). With these instruments within a portable space, there are substantially enhanced possibilities for the exploration of the health effects of real-world pollutants. Here we discuss results of preliminary campaigns in Spring-Summer 2023 targeting wildfire episodes in BC along with exposure characterization in high-traffic urban environments. By understanding this toxicology under atmospheric conditions, relevant conclusions can be made to impact policies and regulations.

2HA.12

Quantification and Characterization of Nanomaterials Shed from Face Masks. RYM MEHRI, Timothy Sipkens, Joel Corbin, Zuzana Gajdosechova, Gregory Smallwood, *National Research Council Canada*

During the COVID-19 pandemic, novel face masks, containing nanomaterials, have been developed and are available in the Canadian and international markets. However, little research has considered the potential health risks associated with these nanomaterials should they become dislodged (shed) from the masks and inhaled by the wearer. This makes it exceptionally challenging to drive standard development and regulation of these new materials. In this work, we develop a novel approach to quantify the nanomaterials shed by face masks, including the composition of the released nanomaterials. Particular is placed on products containing titania (TiO2).

The face masks themselves are first analyzed using inductively-coupled plasma mass spectrometry (ICP-MS) and electron microscopy with energy dispersive X-ray analysis (EM-EDX), to determine the morphology, location and composition of the particles in the samples. Next, the masks will be subject to a variable flow of air to prompt particle shedding. Flow rates will vary up to 85 L/min, roughly mimicking different breathing conditions from light to heavy physical activity. Released particles will be characterized in terms of their number concentration and particle size distribution, using a condensation particle counter and scanning mobility particle sizers, respectively. Shed particles will also be collected onto filters to determine the composition and size of the released particles using EM-EDX and single particle ICP-MS.

These combined measurements will lead to assessments of the particle mass concentration, elemental composition and particle size distribution of the shed particles, which can help in performing risk assessments on these products.

2HA.13

Effect of Photochemical Aging on Residential Wood Combustion Aerosol Toxicity in Airway Epithelial Models at the Air–Liquid Interface.

SVENJA OFFER, Hendryk Czech, Sebastiano Di Bucchianico, Mika Ihalainen, Pasi Yli-Pirilä, Olli Sippula, Yinon Rudich, Ralf Zimmermann, *Helmholtz Zentrum München*

Residential wood combustion (RWC) substantially contributes to the burden of disease attributable to air pollutants by emissions of carbonyl compounds and fine particulate matter ($PM_{2.5}$), which have been associated with adverse human health effects. However, there is only limited knowledge on how atmospheric aging affects the toxicological impacts of emissions.

To study those effects, we burned beech logwood in a chimney stove and aged the emissions in a high-volume oxidation flow reactor “PEAR” for equivalent photochemical ages accounted as 1.4 and 3.3 days by using d9-butanol as photochemical clock. To discriminate toxicological effects, we exposed two cell model systems consisting of either epithelial (A549) or bronchial (BEAS-2B) cell lines at the air-liquid interface for 4 h to the generated fresh, 1.4 or 3.3 days aged RWC aerosols.

In general, we observed considerable toxicity-related outcomes in cells treated with the emissions of RWC. Greater adverse effects were measured for aged compared to fresh aerosols, with some indications of enhanced adverse effects for the longer aging condition. At the functional level, we found that aging of RWC augmented the secretion of malondialdehyde and induced changes in the glutathione redox homeostasis, pointing towards the occurrence of intracellular oxidative stress. The accumulation of the cytotoxic marker lactate dehydrogenase (LDH) in the cell culture media and the reduced metabolic activity of both cell models after the exposure to especially aged RWC emissions, further confirmed the enhanced cellular toxicity induced by photochemical aging. Additionally, longer aging of RWC emissions slightly caused greater LDH release and metabolic activity impairment compared to shorter aging condition.

Altogether, our study highlights the importance of photochemical aging on enhancing toxicity-related outcomes by detecting greater adverse effects after the exposure to aged RWC emissions than fresh emissions in both cell models, with stronger effects of the longer aged RWC emission.

2HA.14

Physicochemical and Toxicological Profiles of Particles from Paired Combustions of California Biomass Species.

SAAGAR PATEL, Amber Kramer, David Park, Tiancong Ma, Tian Xia, Yifang Zhu, *University of California, Los Angeles*

The increased frequency and severity of wildfires on the West Coast due to climate change has led to an increase in emissions of air pollutants. The emission products of these wildfires are complex, and potentially include thousands of species of flora, making toxicity modeling based on plant species difficult. Additionally, hours after a wildfire is contained, the biomass still emits air pollutants that consist of a dramatically different composition of air pollutants. A previous study was conducted where, in a temperature and humidity-controlled chamber, five individual Californian plant species (four native & one invasive) were combusted and their emission products characterized. Emissions were collected immediately after the biomass was ignited and again after a two-hour aging period to determine the profile of emission products that accurately demonstrate human exposure parameters. Significant differences in particle modal diameter, PAH content, and oxidative potential in each individual biomass species led to the synthesis of this study’s design where we seek to explore the possibility of modeling the physicochemical and toxicological profile of two-component combustion experiments using single component combustion data. Additionally, we are interested in examining the interactions between plant species of different material (e.g., grassy vs. woody) and origin (native vs. invasive). Here we pair biomass species in the combustion chamber and evaluate: (1) particle size distribution using SMPS for Particulate Matter (PM) (10 – 500nm) & APS for PM (0.5 – 20 µm) in diameter, (2) polycyclic aromatic hydrocarbon (PAH) profiles using GC-MS, and (3) oxidative potential using both Dichlorofluorescein (DCF) & Dithiothreitol (DTT) assays. Results from this study will provide better understanding wildfire emissions modelling for use in health risk assessments.

2HA.15

In Silico Analysis of Deposition Efficiency of Inhalable Metal-Containing Particles in Human Lung Model. HYEON-JU OH, Jongbok Kim, *Seoul National University*

Exposure of the respiratory system to metal oxide particles poses a major impact on human health. However, gaps remain in identifying and evaluating the potential health effects of inhalation exposures, particularly from aerosol components. In this study, we evaluated simulated exposure scenarios by feeding the total number concentration of four metal oxide particles (Iron-, Copper-, Zinc-, and Titanium dioxide) produced within a 100-liter mixing chamber for particle exposure. The metal content of individual particles was analyzed using Energy-Dispersive X-ray Spectroscopy (EDX). The deposition efficiency of these particles was calculated for different breathing patterns at different regions of the respiratory tract using Multiple-Path Particle Dosimetry (MPPD). The size of released particles obtained from metal oxide aerosols is in the range of 30–250 nm in diameter. The respiratory deposition efficiency was found to be lethal in children under 7 years old of age. For children, higher deposition of particles of less than 100 nm in diameter was due to age-dependent breathing patterns and structural and functional characteristics of the lungs. The deposition fraction was 35% higher in children with age < 7 years than in adults at the end of the deep lung (after the 20th lobe generation). To understand different degrees of sensitivity to inhalable particles, it is necessary to consider different deposition efficiency in age groups and the nature of particles deposited in the respiratory tract. We showed that lung particle deposition by age group is determined by the fraction of tidal volume, which may lead to greater lung health risks in children and might be more serious if the particles contain hazardous metals.

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2HA.17

Measuring Black Carbon Particles in Human Placentae. PHILIP K. HOPKE, Atsuo Chiu, Verda Thomas, Emma Norris, Richard Miller, *University of Rochester School of Medicine and Dentistry*

Exposure to ambient particulate matter (PM) and adverse birth effects including pre-term birth and low birth weight have been reported. Traffic Related Air Pollution (TRAP) is particularly important in inducing adverse effects. A useful indicator of TRAP is black carbon (BC) particles. Prior work reported finding BC particles in human placenta. Thus, translocation of ambient particles from the lungs to maternal blood to the placenta including the fetus may be an important pathway for toxicants that impair placental development and by extension, fetal growth. Tissue was examined using a two-photon laser microscope (Olympus FVMPE-RS) to provide a 3-dimensional image of the sample. BC particles were identified by the relatively uniform light emission across the 4 detection channels and physical diameter of ~ 0.3 µm. From the resulting images, the number of particles per unit volume of each sample were determined using Imaris image analysis (IIA). Initial work determined that formalin precipitation was not a problem, but typical histological stains did produce false positives. Thus, unstained tissue has been examined. Our design was to examine 60 views of a given placenta. Each image was screened using IIA and the computer-identified particles were further assessed manually to ensure that they met the criteria for identification as being BC. We have measured the particle numbers in 5 placentae. Typical numbers per view are 4.52 ± 3.66, 2.83 ± 2.48, and 2.60 ± 2.30, in the material blood, fetal tissue, and fetal blood, respectively. Converting these numbers to particle density (particles per unit volume), we obtained 11,450 ± 9,230, 7,220 ± 6,650, and 6,670 ± 5,920 particles per cubic millimeter for one particular placenta.

This work was supported in part by the RW and MS Goode Grant.

2HA.18

Developing Non-linear Machine Learning Models for Predicting PM2.5 Oxidative Potential Using Its Chemical Components Data in Various Environments. SEUNGHYE LEE, Minhan Park, Ma. Cristine Faye Denna, Dahye Oh, Jiho Jang, Kihong Park, *Gwangju Institute of Science and Technology*

Oxidative potential (OP) is an effective indicator of oxidative stress induced by inhaled fine particulate matter ($PM_{2.5}$). This study aimed to develop a more generalized OP prediction model applicable to diverse environments by exploring various machine learning models. Ambient $PM_{2.5}$ samples were collected from urban (Beijing, China and Gwangju, Korea) and agricultural (Gimje, Korea) sites during both summer and winter seasons. The samples were analyzed for OP and major chemical components. The OP was measured using a dithiothreitol (DTT) assay. Significant differences in volume-normalized OP (OP_v) were observed among the sites, with the Beijing site showing the highest OP_v, followed by Gwangju and the Gimje sites. Site-specific and site-generalized feature selections identified significant and generalized influences of Mn, Cu, Zn, Pb, and water-soluble organic carbon (WSOC) on OP_v. The linear regression model, developed based on selected features, exhibited an overfitting problem as it failed to yield a generalized prediction of OP_v, especially showing poor prediction performance at the Gimje site. In contrast, tree-based ensemble models such as random forest and gradient boosting models demonstrated their effectiveness in predicting OP_v by explaining 75% of the variability of OP_v in the testing data. These models successfully captured the distinct characteristics of each site by appropriately evaluating the importance of each chemical component, capturing non-linear relationships between chemical components and OP_v, and considering interaction effects among chemical components. Furthermore, this study revealed a constrained impact of Cu on OP, which is contingent on the concentration of WSOC. This observation, derived from the utilization of global model-agnostic interpretation methods, emphasizes the significance of antagonistic effects between Cu and organic components on OP, thus highlighting their crucial role in predicting OP_v. Overall, this study provides insights into the development of generalized OP prediction models by identifying key factors influencing the OP of ambient $PM_{2.5}$.

2HA.19

Cellular Response to Delivery of Airborne Particles in Different Deposition Patterns through the Dosimetric Aerosol In Vitro Inhalation Device. SRIPRIYA NANNU SHANKAR, Amber O'Connor, Kiran Mital, Yuetong Zhang, Amin Shirkhani, Alex Theodore, Tara Sabo-Attwood, Stavros Amanatidis, Gregory S. Lewis, Arantzazu Eiguren-Fernandez, Otmar Schmid, Chang-Yu Wu, *University of Florida*

Particle deposition in the respiratory tract occurs in different patterns depending on particle characteristics and an individual's respiratory mechanics. In this study, aerosolized CuO nanoparticles (CuONPs) were deposited in four patterns (spots, ring, slit, and circle) onto A549 cells cultured at the air-liquid interface via the Dosimetric Aerosol *in Vitro* Inhalation Device (DAVID), where the mass of CuONPs delivered was quantified by Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES). ImageJ analysis showed the deposition areas corresponding to spots, ring, rectangle, and circle patterns were ~10, 27, 7 and 68% of the cell culture insert's area, respectively. The “global dose” was calculated as the mass of CuONPs delivered over the surface area of the cell culture insert, while the “regional dose” was calculated as the mass of CuONPs delivered over areas corresponding to the deposition patterns. Assessment of cell viability by alamarBlue assay showed there was no significant difference between spots-ring (p=0.9985), spots-circle (p=0.1522) and ring-circle (p=0.2042) at a global dose of 10 $\mu g/cm^2$, and there was no statistical difference ($p>0.05$) between any of the patterns at global dose of 20 $\mu g/cm^2$. The variation in cell viability with respect to the regional dose shows that the deposition area clearly had an influence in cellular response. The pattern wherein CuONPs were deposited in the least surface area was the slit (~7% of the total surface area of the insert), and this pattern had the highest impact on cell viability. The cell viability was lower for patterns with smaller deposition area, i.e., the cell viability increased in the order slit < spots < ring < circle. The results suggest potential cellular signaling, i.e., communication between cells in response to their environment. The study highlights the importance of considering deposition pattern and comparison of regional and global doses in *in vitro* inhalation toxicology.

2HA.20

Comparative Toxicity of Fresh and Aged Anthropogenic Smoke Particles Emitted from Different Burning Conditions.

YONG HO KIM, Aditya Sinha, Ingrid George, David DeMarini, Andrew Grieshop, Ian Gilmour, *U.S. Environmental Protection Agency*

We demonstrated previously that, on a mass basis, mutagenicity associated with particulate matter (PM) from flaming smoke is greater than smoldering PM. This finding, however, is limited to fresh smoke emissions, which are different from the actual smoke (i.e., photochemically aged smoke) to which most people downwind of combustion events are exposed. Thus, we investigated how chemicals of combustion smoke change in the atmosphere and how such changes promote similar or distinct toxicity outcomes. We generated anthropogenic smoke (a mixture of plastic, plywood, and cardboard smoke) from two different burning conditions (smoldering vs. flaming) with and without photochemical aging and determined toxicity (i.e., mutagenicity and toxicity equivalent) of the smoke particles. Photochemical aging resulted in increased oxygenated volatile organic compound (VOC) emissions but largely degraded particle-bound polycyclic aromatic hydrocarbons (PAHs) in the smoke. Due to the PAH degradation, mutagenicity of the aged smoke from flaming combustion was up to 4 times lower than that of the fresh smoke on a per-particle mass basis. However, on the basis of particle emitted per fuel mass burned (emission factor basis), the aged and fresh smoke particles exhibited similar mutagenic activities, with higher (up to 3 times) in smoldering than flaming smoke. Similarly, the PAH toxicity equivalent of the aged smoldering smoke was 3 times higher than that of the aged flaming smoke particles, suggesting that smoke PAHs in the smoldering smoke were more photochemically stable during aging. These findings increase understanding of the evolution of smoke emitted at different burning conditions and the role of photochemical transformations on mutagenicity and PAH-induced toxicity. [This abstract does not represent EPA policy.]

2HA.21

Performance of a Medical Nebulizer when Testing with a Lung Simulator.

TAEWON HAN, Michael Falvo, Gediminas Mainelis, *Rutgers, The State University of New Jersey*

Medical nebulizers are used to deliver aerosolized drugs and in methacholine challenge testing (MCT), where the constriction caused by methacholine aerosol allows determining bronchial hyperreactivity to a certain concentration of the drug, helping to diagnose asthma. Therefore, it is important to accurately determine the drug aerosolization rate and how that depends on initial liquid volume, drug concentration, and use time; losses inside the nebulizer, i.e., drug remaining on the inner walls of the nebulizer, also play a role in the drug delivery rate. The drug delivery rate is assumed to be a linear function of the aerosolization time. Given the importance of the accurate drug delivery rate in MCT test, we investigated the performance of the commonly used AeroEclipse II BAN nebulizer (Monaghan Medical Corporation, Plattsburgh, NY) as a function of the above parameters using a lung simulator (Michigan Instruments, Grand Rapids, MI) to simulate female and male breathing at 14 of breaths/min and tidal volume of 750 and 900 mL, respectively.

Initial testing showed that the initial drug concentration inside the nebulizer increases with nebulization time, and this factor was taken into account. We found that the nebulizer's drug delivery rate (mg/min) non-linearly depended on initial solution volume (2-6 mL) and operation time (20 sec-10 min); it was linear regarding the drug concentration (0.0625-16 mg/mL). The loss inside the nebulizer ranged from 0.11 to 0.45 mL, and the initial concentration increased by 7% after 10 min of nebulization. When the drug at 16 mg/ml concentration was used, the average delivery rate was 4.5 mg/min over 10 min, compared to 2.7 mg/min reported by the manufacturer. This difference was even higher for 20-sec nebulization: ~7.7 mg/min vs. the same 2.7 mg/min reported by the manufacturer. The results underscore the paramount importance of testing nebulizer performance.

2HA.22

Systematic Characterization of Air and Aerosol Dispersion in Operating Rooms. TERRENCE GARCIA, Benjamin Alvarez, Crystal Butler, Daniel Winker, Erika Yu, Stephanie Ku, Kira Loshin, Michael Morrison, Shirley Klimkiewicz, Sarah Ton, Mika Helfers, Tim O'Hanlon, Megan Toms, Christopher Stiles, Ryan Darragh, Anurupa Bhonsale, Christopher Bradburne, Sarah Grady, Carlos Barajas, Sarah Harrison, Mayalen Brock, Greta Kintzley, Lucy Carruth, Brian Damit, et al., *Johns Hopkins University Applied Physics Laboratory*

Within operating room (OR) settings, the movement of pathogenic droplets and aerosols are of critical concern, particularly in the occurrence of surgical site infections (SSIs). Owing to the highly complex nature of OR environments, new approaches are needed to systematically characterize these spaces and develop evidence-based improvements to infection prevention and control (IPC) practice and the built environment. To address this gap, this study developed a multimodal sensor system comprised of a suite of low size, weight, and power sensors for measuring a range of OR properties including airflow, aerosols, human activity, equipment position, ambient temperature, humidity, door openings, 3D room geometry, and biological burden (proteomic and genomic content). Embedded inconspicuously in an OR, this system can autonomously gather rich spatiotemporally-resolved datasets for characterization of aerosol-generating procedures (AGPs) and droplet and aerosol dispersion in the OR linked to specific events (e.g., door openings and clinician movements) in the context of SSIs. Following development, an active OR at a large public hospital was sensorized for data collection over a three-month period. In sensorizing the OR, computational fluid dynamics (CFD) modeling informed the placement and distribution of aerosol sensors (Alphasense) and environmental samplers (Button samplers) throughout the space. The research team also completed in-person surgical observations to further contextualize surgical events. The results show a size-dependent propagation of aerosols throughout the space during surgical patient care, with absolute aerosol concentrations dependent on the activity, e.g., cautery, fan output from workstation, etc. Early data science-based interpretations indicate that several factors are indeed correlated to air and aerosols being directed toward the patient (and perhaps SSIs), namely, the number of clinical staff in the room, degree of human activity, air velocity at vents, and others. Ongoing data analysis will continue to quantify and generalize these relationships for translation into IPC guidance toward reducing SSIs.

2HA.23

The Relative Stability of Influenza Virus Infectious Unit and Gene Copy Measurements on Surfaces. KE ZHANG, Will Fitzsimmons, Adam Lauring, Krista Wigginton, *University of Michigan*

Influenza viruses are among the most common and most significant causes of human respiratory infections by posing a considerable threat to public health each year. The transmission of influenza viruses depends on infectious virus particles (i.e., infectious units, iu), however environmental measurements often quantify the genome copy (gc) concentrations by PCR-based assays (i.e., gene copies, gc). The ratios of gene copies to infectious units likely change through the release, aging, and collection of viruses from the environment. We quantified both infectious unit and genome copy concentrations for influenza viruses and surrogate viruses (i.e., MS2, and phi6) as they aged on environmental surfaces to help aid in the interpretation of risks from gene copy measurements. We found the gc concentration of RNA viruses are often vastly underestimated due to reverse transcription (RT) efficiencies of less than 100% and therefore optimized our assays to improve RT efficiencies and adjusted the absolute gene copy concentrations to account for RT efficiencies. We observed that the virus gc concentrations were relatively stable on environmental surfaces over several days. Infectious influenza virus concentrations, however, dramatically decreased over the experimental periods, leading to increased gc/iu ratios. Furthermore, we found the changes in gc/iu ratios were affected by environmental conditions (e.g., relative humidity). Our results contribute to the accurate and robust environmental surveillance of influenza viruses, which will improve the transmission models and the assessment of intervention effectiveness.

2IM.1

Comparison of Low-Cost PM Sensors with a Direct Mass Measurement at Sites Representing Road and Non-road PM Sources.

YU JUNG LIN, Karl Armstrong, Roby Greenwald, *Georgia State University*

The use of low-cost PM microsensors for time-resolved personal, occupational, or residential exposure is rapidly increasing. Given that these sensors are typically based on optical methods of detection, inferring mass concentration requires assumptions of particle shape, density, refractive index, and hygroscopic growth. These factors are related to source-specific particle composition as well as meteorological factors including temperature (T) and relative humidity (RH). On the other hand, the Tapered Element Oscillating Microbalance (TEOM) directly measures PM mass with high time-resolution and controlled inlet environmental conditions. We deployed multiple units of three common microsensor models at TEOM-equipped monitoring stations operated by the Georgia Environmental Protection Division. Each sample site is located in a different urban context representing a range of sources: directly adjacent to a 16-lane urban freeway, intermediate-distant (500m) to an 8-lane suburban highway, and an urban background site over 3 km from the nearest highway. We collected microsensor, TEOM, and meteorological data over three days at each site under a variety of meteorological conditions in all four seasons and aggregated all data to 1-hour time resolution. We used multivariate regression models to estimate coefficients for site-specific meteorological and microsensor variables with TEOM data as the reference and assessed model performance using a ten-fold cross validation procedure.

As expected, the mass concentration reported by microsensor devices is substantially different than TEOM measurements and is correlated with ambient T and RH. We observed meaningful differences in regression coefficients across sample sites reflecting variation in hygroscopicity for particles from different sources. Additionally, there is evidence of a seasonal influence on regression coefficients, perhaps a result of the differing levels of biogenic or secondary organic aerosols in this region.

2IM.2

Effect of Aerosol Size Distribution on Uncertainty of Analyte Quantification Using X-ray Diffraction.

KABIR RISHI, Bon Ki Ku, Alan Dozier, Chen Wang, Orthodoxia Zervaki, Vasileia Vogiazi, Pramod Kulkarni, *Centers for Disease Control and Prevention, NIOSH*

X-ray diffraction (XRD) measurement is widely used for quantification of mineral aerosol such as crystalline silica (CS) in workplace atmospheres. Standard methods for quantification of particulate analyte must use standard reference materials that have polydisperse size distributions. Measurement uncertainty can be significant if the unknown aerosol has a different size distribution compared to that of the calibration aerosol. Previous studies have found pronounced/strong effect of particle size on crystalline silica quantification in XRD measurements over a limited particle size range.

The objective of this study was to systematically investigate mesurement uncertainty in analyte quantification using XRD measurements. Size classified aerosols in the diameter range 56 nm to 18 µm were of various crystalline materials were used to obtain size-dependent calibration curves relating diffraction intensity with analyte mass. Different materials including α-quartz, α-cristobalite, iron, gold, sodium chloride were used as test aerosols. The diffraction intensity for most materials agreed with Wilchinsky's theory for predicting variation of diffraction intensity as a function of particle size, except for quartz and cristobalite, where sharp reduction in signal was observed for the sub-micron fractions. Previous studies have attributed such reduction in diffraction intensity to an amorphous layer on silica particles. Examination of surface crystallinity using electron diffraction for smaller particles (<< 1 µm) did not reveal such amorphous layer. We attribute the sharp decrease in diffraction signal to presence of smaller amorphous particles in the standard reference material instead. The overall measurement uncertainty in quantification of CS for varying size distribution of workplace aerosol compared to that of the calibration standard will be discussed.

2IM.3

Maximizing the Output from Filter Sample Analysis: Evolved Gas Analysis from Thermal-Optical Carbon Analysis (TOCA) Using Photoionization Mass Spectrometry (PIMS). Sven Ehlert, Hendryk Czech, Marco Schmidt, Martin Rigler, Andreas Walte, RALF ZIMMERMANN, *Photonion GmbH*

The hyphenation of photoionization mass spectrometry (PIMS) to thermal optical carbon analysis (TOCA) provides insights into the composition of single carbon fractions from filter samples. A small part of the evolving carbon is not converted to CO_2, but enters directly the mass spectrometer through a deactivated transfer capillary for evolved gas analysis (EGA) with soft photoionization techniques, such as single-photon ionization (SPI) and resonance-enhanced multi-photon ionization (REMPI). Thus, it enables molecular information during TOCA without pre-treatment or cost of additional sample material, offering its inclusion in existing air quality programs involving routine analysis of organic (OC) and elemental carbon (EC).

We explore how TOCA-PIMS may serve for the identification of different wood types in stove emissions by molecular feature detection. In a comparison of particulate emissions from beech, birch, and spruce logwood combustion, birch as wood fuel can be rapidly identified by thermal decomposition products of betulin and betulinic acid in the m/z range beyond 350, which is representative for such pentacyclic triterpenoids. Spruce contains significant amounts of diterpenoids in its resin. Those resin components thermally degrade in the m/z range from 302 (e.g. abietic acid) down to 234 (common softwood combustion marker retene). In contrast, for the hardwood beech, only polycyclic aromatic hydrocarbons (PAH) appear in the m/z range above 250.

The coupling of high-resolution time-of-flight mass spectrometry with simultaneous electron ionization (EI) and REMPI generates information comparable to offline aerosol mass spectrometry (AMS), such as elemental composition and carbon oxidation state, together with PAH analysis by REMPI. As REMPI-TOFMS may be regarded as a chemical sensor for the detection of aromatic species, interferences from matrix constituents are negligible. Therefore, REMPI-TOFMS coupled to TOCA enables semi-quantification of health-relevant PAH.

Limitations in resolving isomers are overcome by the addition of hyper-fast gas chromatography to PIMS. Larger oligomeric structures in atmospheric organic matter, such as humic-like substances (HULIS), decompose during TOCA, but may be classified from their degradation products. This extent of the accessible chemical space may support the understanding of atmospheric chemistry.

2IM.5

PTR-MS as a CIMS? Increasing the Range of Detectable Compounds via Low Pressure Negative Soft Chemical Ionization. TOBIAS REINECKE, Markus Leiminger, Markus Mueller, *IONICON Analytik GmbH., Innsbruck, Austria*

Proton-Transfer-Reaction Mass Spectrometry (PTR-MS) is a soft chemical ionization technique to quantitatively detect volatile and condensed organic compounds on a chemical composition level. We recently introduced a next generation PTR-MS, the so-called FUSION PTR-TOF 10k, which merges the advantages of a pristine and well-studied ion-chemistry of a traditional PTR-MS with the high sensitivities and low limits of detection (LOD) of a near-atmospheric pressure chemical ionization mass spectrometer (CIMS). With LODs well below the pptV range, a significantly improved decoupling of the ion-source with the FUSION reaction chamber reducing ionic and neutral interferences and a high resolution TOF-MS (up to 15,000 m/Δm), FUSION PTR-TOF 10k is predestined to study complex mixtures of SOA and respective gas-phase precursors. However, positive chemical ionization with H_3O^+, NH_4^+, NO^+, and O_2^+ mostly limits the application of PTR-MS to organic compounds (with some exceptions like HNO_3 or NH_3).

For this work, the instrument was equipped with bipolar electronics, capable of switching polarity within seconds. A complete redesign of the FUSION ion-molecule reactor allows operation in a reduced pressure CIMS-like tradition: no drift voltage is applied, ions are solely controlled by RF voltages applied to a series of ring-electrodes. Together with the novel Fast-SRI ion source, negative primary reagent ions like CO_3^- and I^- are now additionally accessible, without the need for any hardware modifications. This increases the range of detectable compounds to inorganics like SO_2, H_2SO_4, with 1-min LODs in the single digit pptv range but also other small acids and halogenated compounds become detectable. Additionally, the new FUSION reactor now allows for coupling the instruments with IONICONs renowned particle inlet CHARON. We will present results from a thorough characterization of these new ionization modes based on standards, oxidative flow-tube experiments and ambient measurements for both particle and gas phase.

2IM.6

Novel Approaches to Chemical Identification in Aerosols: PICARD Program Overview. SHERRIE PILKINGTON, *IARPA*

The PICARD program (Pursuing Intelligent Complex Aerosols for Rapid Detection) aims to develop fieldable sensing platforms for the rapid chemical identification of aerosol particles in plumes. The program addresses both point detection (in situ) and standoff capabilities that focus on the complexity of aerosols with non-uniform sizes, morphologies, and chemical composition as well as dispersion in challenging environments. The goal of PICARD is to advance the state of the art for aerosol detection with respect to physics, chemistry, and environmental challenges.

Aerosol particles often have complex physical structures with hazardous chemicals of interest adhered to, encapsulated by, or shielded by environmentally common species such as dust, pollen, or water. In real-world environments, these common species may mask a critical or harmful signal both chemically and physically. There are several types of hazardous chemicals that may be aerosolized. These include toxic industrial chemicals, pollutants, chemical weapons, explosives, and biological toxins. Identification of specific compounds may be difficult due to the number of similar analogues that exist (e.g., there are over 1400 fentanyl analogues found in scientific literature, with hundreds of millions theoretically possible). Finally, the environment where aerosols occur plays an important role in their form, lifetime, and reaction dynamics. The environmental factors include temperature variations, humidity, wind speed and direction, topographical features, and background chemistry.

In this presentation, I will describe multiple approaches currently being pursued by the PICARD program and how they are innovating aerosol collection, sensing, and analysis. I will also discuss methods for quantitatively evaluating the technology and generating reproducible, complex environments for testing.

2IM.7

Fourier Transform Infrared (FT-IR) Organic and Elemental Carbon (OC & EC) Measurements in the Chemical Speciation Network (CSN). ANAHITA AMIRI-FARAHANI, Andrew Weakley, Bruno Debus, Satoshi Takahama, Ann Dillner, *University of California Davis*

The CSN is a component of the National PM2.5 Monitoring Network, whose data is used for characterizing annual and seasonal spatial variation of aerosol and comparison to chemical speciation data collect from other networks. Representing OC and EC using FT-IR method at CSN sites improves the cost, efficiency throughout the network. It is simpler in sample handling and thermal optical reflectance laboratory analysis and less sampler maintenance is needed.

Previous work suggests that CSN sites may require partitioning into two distinct groups of atypical and typical EC for accurate calibration. Evidence in aerosol collected from some sites like Elizabeth, NJ in 2013 indicated elevated concentrations of diesel particulate matter relative to samples collected from the other sites. When samples were pooled together for calibration biased predictions were observed at these sites. A two-calibration solution was devised, one for the atypical sites and the other for the typical sites.

In this work , our first objective is to identify and separate atypical and typical samples using a year of CSN samples to capture seasonal variability. Using a global calibration we designate a site as atypical if, on average, FT-IR predictions errors are much larger than those at the other sites. Our second objective is to select typical and atypical sites to use for calibration. Atypical sites are partitioned using hierarchical cluster analysis (HCA) as the basis for their atypical behavior is unknown. HCA partitions atypical sites using median relative percent bias as well as the ratio of the median pyrolysis (char) artifact measured during thermal analysis (i.e., OP) to EC ratio and median OP/OC. Our third objective is to measure FT-IR OC and EC for all samples. Calibrations are then developed for each cluster determined by HCA. As typical sites are reasonably similar in terms of carbon composition no cluster-modeling is required. Following cluster-modeling, select CSN sites are selected to represent the 140 sites considered in this study. Sites designated as National CORE Multi-pollutant Monitoring Station (NCORE) and Speciation Trends Network (STN) are prioritized. Typical sites are selected for calibration following the application of HCA to samples on six speciation measurements OC/ NH4+, EC/ NH4+, OP, NH4, NO3-, and SO42-. Overall, only 15 (8 atypical + 7 typical) sites appear to represent, to a reasonable degree, the composition of aerosol carbon in the CSN. The impact of COVID on identifying typical versus atypical sites and on prediction capabilities will be investigated.

2IM.8

Chemical Analysis of Aerosol Nanoclusters (2-10 nm) Using a High-Flow Differential Mobility Analyzer Coupled to a Thermal Desorption Chemical Ionization Mass Spectrometer.

PAULUS BAUER, Patricia M. Morris, Véronique Perraud, Barbara Finlayson-Pitts, James Smith, *University of California, Irvine*

Climate impacts of clouds are linked to cloud condensation nuclei (CCN), with the latter linked to new particle formation (NPF) and growth processes. One important phase in NPF is the transition from a fragile cluster, only consisting of several molecules, to a stable particle, with a size larger than 10 nm. The struggle for survival of this aerosol nanocluster (AN), which we define as aerosol particles in the diameter range between 2 to 10 nm, depends fundamentally on their chemical composition, e.g., acid-base ratio, organic salt formation, oxidation state and many more physicochemical properties. On one end, several measurement techniques and models exist that can probe gas-phase clusters up to ~2 nm. On the other end, there a several instruments and models that can directly assess chemical information on nanoparticles larger than 10 nm. However, examining the chemical composition of AN directly has been very challenging.

Here, we used a Thermal Desorption Chemical Ionization Mass Spectrometer (TDCIMS) in combination with a high-flow Differential Mobility Analyzer (DMA) to retrieve chemical information on ANs directly. The Half-Mini DMA (a high-flow DMA, J. Fernández de la Mora and J. Kozlowski, J. Aerosol Sci., 2013) has the advantage of a high resolution and a high transmission in the AN range. This is critical for collecting a high mass yield of size-selected ANs for the chemical analysis by TDCIMS. Electrospray generated salt particles were exploited as a stable and well-defined test aerosol source with a high mass output. In a further step, atmospherically relevant organic salt ANs generated via acid-base reactions in a flow tube are evaluated. This information on the highly dynamic transition from cluster to condense phase has far-reaching consequences for understanding NPF and its climatic implications.

2IM.9

Can Infrared Spectra Functional Group Measurements Improve Organic Aerosol Characterization from Time of Flight-Aerosol Chemical Speciation Monitor (TOF-ACSM)?

NA MAO, Manjula Canagaratna, Nga Lee Ng, Satoshi Takahama, Ann Dillner, *University of California, Davis*

Aerosols affect climate, ecosystems, and human health. Characterizing organic matter (OM) in aerosols is crucial in understanding atmospheric processes in different locations, such as urban and remote areas. The Aerodyne Time of Flight Aerosol Chemical Speciation Monitor (ToF-ACSM) has been used to quantify inorganic and organic aerosols with high time resolution for a decade. However, the significant fragmentation of organic molecules by the electron impact ionization source creates uncertainties in analyzing organic aerosol compositions. Fourier transform- infrared (FT-IR) spectra measure functional groups in bulk aerosols but are limited by their low temporal resolution compared to ToF-ACSM. Using multivariate techniques, this study systematically explores the relationships between fragment ions from several individual compounds representative of carboxylic acids and alcohols, and multi-functional compounds and their measured functional groups. The fragment ions and functional groups are obtained using ToF-ACSM and FTIR, respectively. First, a PTFE filter-based OM functional group calibration was established using a wide range of chemicals with multiple functional groups such as carbonyl (CO), non-acid carbonyl (naCO), carboxylic acid (COOH), alcohol OH (aOH), alkane (CH), and unsaturated hydrocarbon (UnsCH), using partial least square (PLS) regression. Second, mass spectra of fragment ions are collected for the same chemical species. Third, the correlations of ACSM fragment ions with functional groups and spectral features are explored to assess how FT-IR spectroscopy can enhance the ToF-ACSM organic characterization.

2IM.10

HPLC-PDA Method Development, Validation, Optimization, and Comparison with GC-FID for The Quantification of Organic Acids. ESTHER OLONIMOYO, Naresh Kumar Amradi, Stephanie Lansing, Akua Asa-Awuku, Candice M. Duncan, *University of Maryland*

Substantial uncertainties are associated with aerosol chemical composition and secondary organic aerosol formation mechanisms. Current models only consider acetic and formic acids, thereby underestimating organic acid atmospheric concentrations by 50%. In this work, we developed and validated a fast analytical method for a High-Pressure Liquid Chromatograph coupled with a Photodiode Array detector (HPLC-PDA) for quantifying six monocarboxylic organic acids: formic, acetic, propionic, butyric, isovaleric, and valeric acids. Analyte separation was performed on an XBridge C18 (4.6 x 150 mm, 3.5 µm) column using a mobile phase solution composed of 10% acetonitrile and 10 mM potassium dihydrogen phosphate buffer solution (KH_2PO_4) acidified with phosphoric acid (H_3PO_4). We optimized existing methods by investigating elution modes, mobile phase pH, and column temperature to improve peak resolution and shorten analysis time. Our proposed method is characterized by a gradient elution mode with flow rates ranging from 1 to 2 mL min $^{-1}$ and a short analysis time (< 8 mins). The calibration curves showed excellent correlation ($R^2 > 0.999$) and peak resolution (> 1.5). The limits of determination for all six acids (LOD) ranged from 0.87 to 1.51 ppm, while the limit of quantification (LOQ) ranged from 2.63 to. 4.59 ppm. We also compared the optimized HPLC method and a Gas Chromatograph coupled with a Flame Ionization Detector (GC-FID) method to investigate technique suitability for organic acid analysis based on sensitivity, precision, and dynamic range. Our preliminary results indicate greater sensitivity and precision at lower concentrations, thus showing that the HPLC system is better suited for monocarboxylic organic acids. Lastly, the HPLC method was applied to fog and rainwater samples collected from a building rooftop in an urban environment.

2IM.12

Use of Electrostatic Collector for Real-time Personal Exposure Monitoring of Ultrafine Particles. Shaelyn Chen, Erkam Cakmak, Chengyu Zhang, Yifan Liu, Ching-Hsuan Huang, Byron Ockerman, IGOR NOVOSSELOV, *University of Washington*

Ultrafine Particulate (UFP) pollutants include a complex mixture of aerosols with varying chemical compositions and particle sizes. Long-term exposure has been associated with adverse health effects and increased mortality rates. Scanning mobility analyzers can measure the concentration of UFP based on their electrical mobility; however, these instruments are relatively large and too expensive to be used as personal exposure devices. We aimed to develop a miniature electrostatic particle collector that can track UFP personal exposure in real time. Our device utilized an electrostatic field to collect UFP on a transparent substrate combined with real-time light transmission measurements. Using laboratory combustion-generated aerosols such as wood smoke, and cigarette smoke, our collector was able to reach collection efficiency greater than 50%. Additionally, based on continuous transmission measurements, we achieved real-time monitoring for several types of UFPs with ~10ug sensitivity. The collection efficiencies and transmission experiments provide proof of concept data for the method optimization and development of a miniature sensor.

2IM.13

Incorporating Droplet Growth in Simulating the Performance of Condensation Particle Counters. MARCUS BATISTA, Weixing Hao, Michel Attoui, Yang Wang, *University of Miami*

The measurement of airborne particles with sizes below 3 nm is critical for the understanding of atmospheric nucleation and elucidating important particle synthesis mechanisms in the gas phase. Condensation particle counters (CPCs) have been widely used to measure the concentration of aerosols. However, due to the insufficient activation and condensational growth of particles, it is difficult for the CPC to measure particles below 3 nm. Methods have been proposed to increase the saturation ratio of the condensing vapor to promote the detection efficiency of sub-3 nm particles in the CPC, as shown by our recent work the influence of CPC operating conditions on particle activation efficiency (Hao et al., 2021).

Existing models simulating CPC particle detection focus primarily on particle activation. However, upon activation, vapor condensation affects the size of the grown droplets, which, in turn, influences their detection efficiency depending on the performance of the photodetector. Adjusting the detection efficiency is crucial to CPC detection limits and increases the chances of counting sub-3 nm particles. Here, using COMSOL and MATLAB, we introduced a probability function to incorporate droplet growth and simulate the size-dependent particle detection efficiency in a sheathed laminar flow CPC. We defined a critical detectable droplet size ($D_{d,c}$) that is associated with the performance of the photodetector. Our simulation demonstrates that the particle size corresponding to 50% detection efficiency ($D_{p,50}$) increases from 2.9 to 3.4 nm when Dd,c increases from 10 µm to 15 µm for the CPC 3025A design. Also, the detection efficiency is not sensitive to size when $D_{d,c}$ is below 10 µm. Our results demonstrate that improved optical component design can enhance sub-3 nm particle detection. The influence of working fluids and temperature will be further discussed.

Hao et al., 2021, J. Aerosol Sci., 158: 105841.

2IM.15

Development of a Low-Cost, Open Source Condensation Particle Counter (CPC). AARON COLLINS, *OpenAeros LLC*

For 100 years, condensation particle counters (CPCs) have used supersaturated vapor to grow particles to optically detectable sizes. The most ubiquitous style is the continuous, laminar-flow forced convection design. Many improvements have been made, including reducing the minimum detectable particle size, response time, and simpler working fluids such as water. However, little effort has been focused on reducing cost and thus increasing accessibility. In this work, the design of a low-cost, open source condensation particle counter ("OpenCPC") is presented. Inventive elements that both improve on the existing technology and cost-saving measures are employed, enabling manufacture of the OpenCPC for approximately an order of magnitude less than other commercially available CPCs, based on bill-of-material costs. These features include a low-cost optical design, featuring a lens-less scattered light collection system, a tightly focused laser module, and an off-the-shelf nozzle. Additionally, a low-cost flow control system leverages the optical pulse width of particles as they traverse the beam providing a measurement of gas velocity at the nozzle, and thus flow rate. One challenge with CPC optical detectors is the flow entering the detector is saturated with vapor which can result in condensation on the optics if the temperature is below the vapor dew-point. Traditionally, this is avoided by heating the optical detector above the dew-point, but it is not possible to heat the thermally insulating plastic used in this low-cost optics design. To overcome this obstacle, a bifurcated flow concept is used wherein a portion of the inlet flow bypasses the saturator and condenser sections and is reintroduced in the optics as a sheathing flow to prevent the primary vapor laden flow from condensing within the optical detector.

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2IM.17

Performance of the Point Sampling Method and Inter-Comparison with State-of-the-Art Remote Emission Sensing.

MARKUS KNOLL, Martin Penz, Tommaso Rossi, Simone Casadei, Alexander Bergmann, *Graz University of Technology*

Emissions from internal combustion engine vehicles are currently not properly monitored during their entire lifetime. Remote emission sensing (RES) is a promising technique for screening in-use vehicles. State-of-the-art open-path RES systems deliver acceptable emission factors (EF) for gaseous species, but lack accuracy for particulate matter (PM). Extractive point sampling (PS) is an alternative approach that is capable of screening different particle metrics, such as particle number (PN) concentration or black carbon (BC). To date, detailed studies evaluating the PS method as well as performance comparisons with commercial open-path RES are missing.

Validation measurements were performed with test vehicles equipped with portable emission measurement systems (PEMS). Next to the PS system, the commercial open-path RES system EDAR (HEAT) was co-located for 8 days. Further co-located measurements were conducted with the open-path RES system AccuScan™ (OPUS) during two city measurement campaigns.

For the PEMS test drives, a strong correlation (R^2=0.97) was found between PEMS and point sampling PN EFs. Absolute values are in good agreement with a median deviation of 22 %. BC EFs from PS were compared against PM EFs from the EDAR system and the PEMS PN results. For a high PM emitter, a good agreement was found for PS BC (R^2=0.66) and EDAR PM (R^2=0.47) compared against the PEMS PN results. For a second, lower-emitting diesel vehicle, the PS system delivers a good performance (R^2=0.76) in contrast to the EDAR system (R^2=0.01). In addition to the test drives, the results from the overall vehicle fleet measurements of several 1,000 vehicles were compared. Average values of PS BC and EDAR PM are in good agreement (115.46 mg/kg fuel, 85.77 mg/kg fuel), but median values differ by a factor of over 30 (16.25 mg/kg fuel, 0.46 mg/kg fuel).

2IM.18

Clusters Formed in Heavy Ionic Liquids as Potential DMA Standards.

CHANAKYA BAGYA RAMESH, Luis-Javier Perez-Lorenzo, Yang Wang, Michel Attoui, *University of Miami*

Heavy ionic liquids developed at The Air Force Research Laboratory are of interest in electrical propulsion, and are being evaluated at Yale for the distribution of mass/charge and the stability of their clusters produced upon electrospraying. In this study, we have evaluated the potential of these clusters to be used as mobility standards, in functions such as the evaluation of differential mobility analyzers (DMAs). We have investigated two room temperature molten salts, referred to as IL-A ($[A^+A^-]$, with $A^+=C_{17}H_{16}F_{17}N_2S^+$; $A^-=C_2F_6NO_4S_2^-$) and IL-C ($[C^{++}A^-]$, with $C^{++}=C_{18}H_{32}N_4^{+2}$). The ionic liquids were diluted in methanol and electrosprayed into a parallel plate DMA for classification, after which they were introduced into a time-of-flight mass spectrometer (MS) covering the m/z range of up to 5000 Da. IL-A has a monovalent cation (A^+) while IL-C has a divalent cation (C^{++}). Both ILs share the same monovalent anion. Within the mass range considered, we see that IL-C forms several singly charged clusters in the form $[C^{++}(C^-)_2]_n(C^{++}C^-)$ with $0 \le n \le 5$. For IL-C the most abundant signal corresponds to n=0 at m/z=548.18 Da with mobility 1.05 cm^2/Vs and FWHM of 4.5%. For the same mass range, IL-A forms clusters in the form $[A^+(A^-)]_n(A^+)$ with $0 \le n \le 4$. The most abundant signal corresponds to n=0 at m/z=603.07 Da with mobility 1.16 cm^2/Vs and FWHM of 10.6%. Upon increasing the sheath flow, we see peak width for cations from both ILA and ILC reduce from 10.6% to 7.9% and 22.4% to 18.8% respectively. At the same time, peak widths for largest clusters did not change significantly and remained at 2.7% and 2.1% for IL-A and IL-C. Suggesting that the widths are intrinsically a range of mobilities. These are comparable to width of least mobile peak corresponding to the salt tetradodecyl ammonium bromide.

2IM.19

Development of New Multiscale Aerosol Observing Systems for Deployment at the 3rd ARM Mobile Facility (AMF3) Bankhead National Forest (BNF) Site.

ASHISH SINGH, Chongai Kuang, Andrew McMahon, Scott Smith, Tamanna Subba, Shawn Serbin, Jenni Kyrouac, Adam K Theisen, Allison McComiskey, *Brookhaven National Laboratory*

The DOE ARM user facility is relocating the 3rd ARM Mobile Facility (AMF3) to the Southeast United States for a five-year deployment starting in the Fall of 2023, with sites focused in the area of Bankhead National Forest (BNF) in Northern Alabama. The Southeast United States is a region characterized by high vegetative emissions of volatile organic compounds, a wide range of anthropogenic emissions from proximity to rural areas and dense urban cores, biomass burning from periodic prescribed and unplanned burning, and large amounts of secondary organic aerosol. New aerosol measurement systems are proposed for the campaign to better characterize land-surface controls on the spatial distribution of aerosol properties and processes, and to better understand the exchange of aerosols and trace gasses between the forest canopy and the atmosphere. This abstract will present the plans and progress for developing a distributed aerosol-sensing network to characterize aerosol spatial heterogeneity, and a tower-based aerosol flux system to characterize atmospheric dynamic controls on aerosol vertical transport in the AMF3 BNF domain. Both measurement systems entail platform-specific instrument considerations (e.g., physical footprint, measurement resolution, accuracy, uncertainty), and supporting measurement infrastructure considerations (e.g., a well-characterized sampling inlet, environmental enclosure, robust remote interface for data acquisition, and system diagnostics/calibration). Specific design details corresponding to desired measurement targets, instrument selection and evaluation, and operational requirements will be presented.

2IM.20

Vapor-Phase Transmission Electron Microscopy for Submicron Visualization of NaCl Aerosols and Droplets.

MARTIN AHN, Yuhang Wang, Dewansh Rastogi, Kotiba A. Malek, Jiayue Sun, Taylor J. Woehl, Akua Asa-Awuku, *University of Maryland, College Park*

Single particle measurement techniques, such as electrodynamic balance (EDB) and atomic force microscopy (AFM), provide valuable insights regarding morphology and phase on supermicron-scale systems. Following this trend, we developed a novel application of electron microscopy to image submicron-scale aerosol particles. Using hermetically sealed microfluidic chambers, vapor-phase transmission electron microscopy (VPTEM) allows for in-situ observation of droplet formation from aerosol particles. This novel application of electron microscopy provides submicron and nanoscale visualization of aerosols under relevant atmospheric conditions. Furthermore, the ability to introduce water vapor into the sample holder enables deliquescence and efflorescence studies of these aerosol particles. In this work, the humidification and dehumidification processes are visualized under the VPTEM, and the deliquescence (DRH) and efflorescence (ERH) of the visualized aerosol particles can be obtained. Studies show that sodium chloride particles exhibit small amount of growth prior to the sudden increase due to deliquescence. Additionally, the DRH found using this novel method is significantly lower than that found in the published literature and those determined from bulk-aerosol measurements like the HTDMA measurements. Using the foundational knowledge provided by the simple NaCl/water vapor system, future work will investigate more complex aerosol mixtures under water and organic vapors.

2IM.21

Practical Characterization and Modeling of Higher Flow in a Water Condensation Growth Tube Bioaerosol Sampler.

Dominick Heskett, BRADEN STUMP, Patricia Keady, Gregory S. Lewis, Arantzazu Eiguren-Fernandez, *Aerosol Devices Inc.*

The BioSpot-VIVAS™ bioaerosol sampler currently has a default flow rate of 8LPM. During ambient bioaerosol sampling, higher volumetric flowrate is highly desired. Higher flow rates can reduce sampling time required to achieve limit of detection and can provide better statistical significance in experimental results. It was recently hypothesized based off work previously completed at Aerosol Dynamics that the BioSpot-VIVAS™ sampler's growth tube could be operated with the same efficiency of aerosol capture (in certain environments) above 8LPM, up to 15LPM. This hypothesis was tested via two methods. Uranine collection efficiency testing and modeling was performed to confirm activation of aerosol, and to confirm and quantify the performance of the BioSpot-VIVAS bioaerosol sampler at higher flow rates. Computational Fluid Dynamics modeling was also completed on the inlet of the instrument to confirm large aerosol 2.5 um – 10 um are efficiently transported through the inlet of the instrument into the growth tubes. These experiments aim to confirm that the BioSpot-VIVAS™ bioaerosol sampler can be operated at flowrates up to 15 LPM without compromising scientific specifications.

2IM.22

Developing an LED-powered 8 m3 Environmental Chamber for Studying the Atmospheric Chemistry of Outdoor and Indoor Air.

RICKEY LEE, Paul Heine, Ayomide Akande, Nadine Borduas-Dedekind, *University of British Columbia*

Environmental chambers are controlled reaction vessels used to investigate atmospheric processes such as photochemical reactions and secondary organic aerosol (SOA) formation. As such, we are developing an LED-equipped modular environmental chamber that will be able to represent typical outdoor and indoor environments. The modularity of the chamber stems from using a framing system which connects 12 aluminum T-slot rails into a frame (2.66x2.66x3 m, 80/20 Rocky Mountain Motion Control). Inside the frame hangs a chemically inert and UV-transparent 8 m^3 reaction vessel made of fluoropolymer-based film (Ingeniven). The bag hangs on a pulley system in order to collapse or expand the bag to perform batch mode and continuous mode experiments. During these experiments, the bag connects to a Vocus PTR-TOF (TOFWERK) to measure VOC species in real-time, and to a scanning mobility particle sizer (SMPS) to monitor for SOA formation. Our chamber uniquely uses LED lights (Violumas) of four different wavelengths: 275, 310, 365, and 385 nm, instead of typical fluorescent lights to offer wavelength-specific modularity. Additionally, LED lights are more energy efficient, generate less heat compared to fluorescent lighting, and allow for tunable wavelengths to best simulate a solar spectrum. LED testing (3 x 50 W Violumas 310 nm LED bars) for photolysis of H_2O_2 to OH radicals for the oxidation of α-pinene and mesitylene result in $[OH]_{ss}$ of 2E+6 molecules/cm^3 at 26°C. We are currently working on extending the LED setup in order to obtain a spectra as close to outdoor and indoor light as possible. Overall, our chamber will allow us to study topics of current interest in atmospheric chemistry: from the fate of indoor air fragrances to cannabis emissions to wildfire aerosol photochemical changes and to biogeochemical cycling of selenium.

2IM.23

Measurements of Aerosol Size Distribution and Particle Number Concentration from a Novel Heated Tobacco Capsule (HTC) Prototype.

CHIH-HSIANG CHIEN, Hiral Patel, Matt Melvin, Weiling Li, Yezdi Pithawalla, *Altria Client Services LLC*

Heated Tobacco Products (HTP) contain a tobacco substrate that is heated to low temperatures (below 350°C), resulting in an inhalable nicotine-containing aerosol. For HTP, test data on aerosol design parameters, such as count medium diameter and particle number concentration are required for regulatory submissions as per the Premarket Tobacco Product Applications and Recordkeeping Requirements Final Rule issued by the Food and Drug Administration in 2021. Currently, there is no defined standardized methodology for HTP aerosol characterization. The objective of this work is 1) to present the measurement methodology we developed, and 2) to compare the results from the analysis of a novel heated tobacco capsule (HTC) prototype to those from the analysis of other HTPs. The HTC prototype consists of a hand-held battery-operated device (BVR 3.2) and a disposable tobacco-containing capsule that is inserted into the device. HTP aerosol was generated under an intense puffing regime (ISO 27088, 55 cc puff volume, 2 s puff duration, 30 s puff interval, and bell-shape puff profile). Due to the high concentration of HTP aerosol, two dilution systems were designed. A scanning mobility particle sizer was used downstream to measure the count medium diameter, while a condensation particle counter was used as the detector for measuring the particle number concentration. The results show the aerosols from different HTPs have count medium diameters in the range of 100 to 200 nm, and particle number concentrations around 10^9 particles/cm^3. Additionally, we developed a low-flow cascade impactor method coupled with a pressure-feedback loop interface for aerosol size measurement. The impactor sampling system was designed to control humidity to minimize aerosol evaporation. The results of measurement using different methodologies will be discussed.

2IM.24

Characteristics of Condensable Particulate Matter Formation in the EPA Method 202 Sampling Train.

PAUL VAN ROOY, Dave Nash, Jason Dewees, Ned Shappley, Walter Lin, Peter Kariher, *US EPA*

In the atmosphere, condensable particulate matter (CPM) forms when stack exhaust cools resulting in organic and inorganic gasses condensing on to existing solid particulate or liquid droplets. As particulate controls become more effective at removing filterable particulate matter, CPM mass is quickly becoming the dominant fraction of measured source emissions. EPA's Method 202 (40 CFR Part 51, Appendix M) is the recommended methodology for state, local, and tribal agencies to use for measuring CPM. In the Method 202 sampling train, the CPM is collected in dry impingers after filterable PM has been collected. The organic and aqueous fractions of the impingers and an out-of-stack CPM filter are then taken to dryness and weighed. As it exists now, EPA Method 202 provides a method-defined CPM mass. However, stakeholders have raised concerns over potential measurement bias. Additionally, there are questions regarding the relationship between Method 202 determined CPM mass and the actual CPM mass formation in the atmosphere. While this relationship between real-world and method-defined CPM mass is not necessary for compliance, it is paramount for understanding local and regional air quality issues and determining the most efficient and effective paths for reducing PM. For the past several years, EPA has been conducting controlled laboratory experiments to investigate the formation of CPM in the Method 202 sampling train. A wide variety of initial conditions relevant to stack emissions were studied to understand the impact of humidity, precursor concentrations, and general method variability on CPM composition and mass formation in the sampling train.

2IM.25

PALMS-NG: A Unique Dual S-Shaped Time-of-Flight Mass Spectrometer for Atmospheric Measurements. JUSTIN JACQUOT, Xiaoli Shen, Maya Abou-Ghanem, Karl Froyd, Michael Lawler, Gregory Schill, Kyra Slovacek, David Thomson, Daniel Murphy, Daniel Cziczo, *Purdue University*

The newly developed Particle Analysis by Laser Mass Spectrometry – Next Generation instrument (PALMS-NG) has now performed real-time single particle measurements onboard three research aircraft. It is designed to primarily operate on stratospheric airplanes (NASA ER-2 and WB-57F) with limited payload capacity and large variability in pressure (sea level to 50 mbar) and temperature (-70 to +50 °C). In 2023, PALMS-NG has been adapted to fly onboard the NASA DC-8 aircraft for tropospheric aerosol measurements.

PALMS-NG represents an evolution of the existing laboratory and aircraft PALMS instruments. New features have been implemented, which include a new aerodynamic inlet, revised optics, a pair of unique s-shaped time-of-flight mass spectrometers (sTOF-MSs) for bipolar ion detection and full control of the instrument from the ground when in flight. Two continuous wave (CW) 405 nm lasers are used for particle detection and geometric and aerodynamic size estimation. One of the CW lasers triggers a 193 nm UV light pulse from an excimer laser that ablates and ionizes the particle. The new design of the aerodynamic inlet combined with new optics allow PALMS-NG to measure particles from 0.1 to 4 µm. The novel sTOF-MS geometry makes it possible to fit two mass spectrometers in a volume that previously allowed only a single reflectron, thus enabling acquisition of bipolar spectra for each detected particle. In addition, the longer ion path length and electrostatic sectors that ions traverse before reaching the detector result in a higher ion transmission efficiency (~100%) and higher mass resolution (~1000). Despite the modernized and upgraded hardware of PALMS-NG, all data acquired remain fully comparable with the 30-year data record obtained from the original PALMS instrument.

2IM.26

CHART: A Modular Research Tool for Testing of Protection Against Highly Toxic Aerosols. TOM VENEMA, Dinesh Durán Jiménez, Duurt Alkema, Ruud Busker, Arjan van Wuijckhuijse, *TNO*

Global concerns over the possibility of intentional release of highly toxic chemicals have urged interest into fabrics to protect against vapours as well as aerosols. Concurrently, there is a need for critical experimental assessment of the protection capabilities against chemical aerosols. We therefore present a tool to evaluate physical protection materials against chemical aerosols, i.e. the Chemical Hot Aerosol Research Tool (CHART).

CHART is an modular research tool which has been initially deployed for the evaluation of off-the-shelf detectors for highly toxic chemical aerosols. Recently, the option to evaluate the performance of protective materials against live aerosolized agents has been implemented. Additionally, the modular fashion of the CHART provides the possibility to perform other relevant hot aerosol research, such as toxicology and agent fate assessment studies

The efficiency of fabrics, filters or other air permeable materials is being evaluated against live agents using the swatch module. The aerosol can be dispersed as liquid or solid according to the required specifications, within the broad dynamic particle size range of 0.5 to 3 µm and dynamic mass range of 0.01 – 20 mg/m3. The aerosol is measured and characterized in real time before and behind the swatch by optical particle counters or aerodynamic particle sizers. Characterizing the aerosol twice allows for a comprehensive assessment of mass and size of particles that penetrate through the filter material. The required linear velocity through the fabric is dependent on the material properties of the fabric, and is taken into account.

The present study focuses on the current characteristics and future capabilities of the CHART as a validated, safe, toxic chemical aerosols Test and Evaluation tool for swatch-testing. The set-up and validation of the CHART system will be presented, exemplified by preliminary tests.

This work was funded by the Dutch Ministry of Defence under grants V1802 and V2207.

2IM.27

Experimental Investigation of Aerosol Particle Loss from Sampling Tube Surface Roughness for Aviation nvPM Regulatory Measurements.

FERGUS LIDSTONE-LANE, Paul Williams, Amanda Lea-Langton, Mark Johnson, *University of Manchester*

It is estimated that 16,000 premature deaths are caused by aviation emissions annually (Quadros et al, 2020). Further to this, aviation emissions are thought to cause significant negative impacts on the environment, as they are the main source of anthropogenic particulate sources in the upper atmosphere (Jonsdottir et al, 2019).

In response to the growing aforementioned concerns, the ICAO has introduced a global nvPM emissions reporting standard to regulate the emitted concentrations of nvPM. The standard is relevant for all in-production and new gas turbine engines above 26.7 kN (ICAO, 2017).

Due to the harsh environment at the aircraft engine exit, long sampling tubing is used to transport the exhaust sample to the measurement systems. Transporting the nvPM sample through the long sampling tubes results in large nvPM losses that can be described by many aerosol loss mechanisms, the dominate aerosol loss mechanism is caused from diffusional deposition (Hinds, 1998).

One parameter that can enhance aerosol diffusional deposition is the sampling tube surface roughness (El-Shobokshy, 1982) through increasing the losses caused by eddy-diffusion (Hussein et al, 2012). This loss mechanism become more prevalent when sampling in turbulent regimes.

For regulatory nvPM measurements, a specified correction factor is applied to account for nvPM losses (ICAO, 2017). This correction factor does not account for any losses caused by the surface roughness, and only stipulates that a significantly smooth tube should be used.

This study provides a thorough analysis quantifying the relative effect of aerosol particle loss for a variety of sampling tube surface roughness's – from 0.25 µm to 8 µm. This study also includes an investigation of aerosol particle loss on convoluted tubes – which represent an exaggerated surface roughness. Further to this, the flow regime and sampling tube diameters will be varied to understand a range of sampling situations.

2SS.1

PM10 Is Not PM2.5: A Study on Fenceline Communities in Southeastern PA.

SHIVANG AGARWAL, Mina Tehrani, Kirsten Koehler, Peter F. DeCarlo, *Johns Hopkins University*

Particulate matter (PM) has a significant impact on public health, with both $PM_{2.5}$ and PM_{10} exposure linked to adverse health outcomes. While policies and government efforts focus on $PM_{2.5}$, PM_{10} is often overlooked despite its short-term exposure causing irritation and inflammation in the upper respiratory tract amongst other health problems. This study aimed to evaluate the spatial variability of PM_{10} compared to that of $PM_{2.5}$ at six locations in southeastern Philadelphia.

The study validated a moderate-cost PM sensor, the Quant-AQ MODULAIR-PM, which combines nephelometry with optical particle counting (OPC), compared to filter-based Multi-Orifice Uniform Deposit Impactor (MOUDI) gravimetric measurements. Strong linear correlations were observed for both $PM_{2.5}$ (orthogonal regression slope= 1.08, r= 0.97) and PM_{10} (1.17, 0.90), indicating that the MODULAIR-PM is an accurate measure of both pollutants.

Using the network of 6 sensors in the study area, we identified seven likely violations of 24-hour average PM_{10} concentration (>150 $\mu g/m^3$) for calendar year 2022, showing the importance of continuous PM_{10} measurements. To understand variability of $PM_{2.5}$ and PM_{10} spatially across the study area we compared each individual monitor to the average of all 6 monitors. We found that the slopes of the regression for the $PM_{2.5}$ measurements varied between 0.81-1.18, while the slopes comparing PM_{10} measurements varied between 0.52-1.76, indicating higher spatial variability for PM_{10}. The study highlights the importance of studying both $PM_{2.5}$ and PM_{10} since coarse fraction in PM_{10} behaves differently and originates from dissimilar sources.

In conclusion, this study underscores the need to improve regulatory monitoring infrastructure for PM_{10} and emphasizes the importance of reliable sensors for accurately measuring this pollutant. The study findings highlight the need for further monitoring in areas where violations of PM_{10} concentrations may occur.

2SS.2

Comparison of Summertime Aerosol- and Gas-Phase Measurements at Two Urban Atlanta Sites. ALISON FANKHAUSER, Ruizhe Liu, Asher Mouat, Aryiana Moore, Ann Dillner, Roya Bahreini, Armistead G. Russell, Jennifer Kaiser, Nga Lee Ng, *Georgia Institute of Technology*

The southeastern United States has historically been a popular location to study atmospheric composition and air quality, in part due to complex interactions from strong biogenic and anthropogenic emissions. In particular, Atlanta is well-known for its heavy traffic, resulting in vehicular emissions, and also has a strong biogenic influence due to the dense tree canopy. Atlanta experiences exceedances of the National Ambient Air Quality Standards (NAAQS) due to high concentrations of fine particulate matter and ozone, especially during the summertime. To investigate the current state of air quality in Atlanta, Aerosol Chemical Speciation Monitors (ACSMs) were deployed to measure the composition of submicron, nonrefractory aerosols. Additionally, formaldehyde and NO_x analyzers collected concentrations of gaseous formaldehyde and nitrogen oxides, respectively. All measurements were simultaneously collected at two sites in the greater Atlanta area for several months during the summer of 2023. One site is on the Georgia Institute of Technology (GT) campus in midtown Atlanta. The other site, South DeKalb (SDK), is in a mixed commercial-residential area approximately 15 km east of downtown Atlanta. SDK is one of twelve sites comprising the Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT). Preliminary analysis shows comparable time series for aerosol composition at both sites, with organic aerosol comprising >80% of non-refractory aerosol mass on average. We report trends and concentrations of aerosol species, formaldehyde, and nitrogen oxide between the two urban Atlanta sites, GT and SDK.

2SS.3

Summer and Fall 2023 Update of an Ongoing Aethalometer-Based Black Carbon Measurement and Source Apportionment Campaign at Long-Term Monitoring Sites in Addis Ababa, Ethiopia as Part of the Multi-Angle Imager for Aerosols (MAIA) Investigation. L. DREW HILL, Sina Hasheminassab, Jeff Blair, Steven Blair, Ivan Iskra, Tesfaye Mamo, Araya Asfaw, David Diner, *Aethlabs*

Particulate matter (PM) smaller than 2.5 microns in diameter ($PM_{2.5}$) is a well-known health hazard. Previous investigations have demonstrated that the risk imposed by exposure to $PM_{2.5}$ varies by its chemical composition. NASA's Multi-Angle Imager for Aerosols (MAIA) investigation seeks to add better characterize the toxicity the major constituent components of $PM_{2.5}$ by integrating satellite observations with ground-based speciated PM measurements at a 1 km resolution in 11 global Primary Target Areas (PTAs). One such component is black carbon (BC) – an aerosol commonly produced by the combustion of petroleum or biomass fuels. We present findings from surface measurements of $PM_{2.5}$ and BC taken in the Addis Ababa PTA, adding data from summer and early autumn 2023 to an ongoing analysis of the first-ever year-long continuous BC measurements in Addis Ababa, which began approximately in the spring season of 2022. Preliminary analysis from Summer and early Fall of 2022 show average BC levels between 5 - 10 $\mu g/m^3$ and suggest BC may contribute approximately 10-20% of ambient $PM_{2.5}$ mass concentrations in the region during this period – a $BC/PM_{2.5}$ fraction higher than values observed at the same time in other more well-studied PTAs like Beijing and Los Angeles. Source-specific contributions to BC concentrations will be estimated using the Aethalometer Model, and meteorological data will be used to infer policy-relevant information about these sources.

2SS.4

Monitoring Smoke from Landscape Fires in the Flint Hills Region of Kansas during the 2022 Burning Season. OLIVIA SABLAN, Bonne Ford, Emily Gargulinski, Melanie Hammer, Giovanna Henery, Shobha Kondragunta, Randall Martin, Zoey Rosen, Kellin Slater, Aaron van Donkelaar, Hai Zhang, Amber Soja, Sheryl Magzamen, Jeffrey R. Pierce, Emily Fischer, *Colorado State University*

In the Flint Hills of eastern Kansas, annual springtime (March - May) prescribed burning is practiced to boost cattle weight gain, control invasive species, and maintain ecosystem diversity and health in the tall grass prairie. Smoke produced from these prescribed fires adversely impacts air quality and visibility. Regulatory monitors for fine particulate matter ($PM_{2.5}$) are located only in urban and suburban areas around the Flint Hills, which has afforded a limited understanding of the extent of smoke impact in rural communities. To quantify the contribution of springtime prescribed burning to $PM_{2.5}$ concentrations in the Flint Hills and downwind regions, we deployed 37 PurpleAir $PM_{2.5}$ sensors for the 2022 burning season. We use observations from this ground-based network alongside a suite of satellite products (e.g., NOAA Hazard Mapping System, GOES Aerosol Optical Depth) to determine the $PM_{2.5}$ attributable to smoke. In 2022, the Flint Hills were also impacted by dust and transported smoke from high winds, drought, and wildfires in New Mexico. Here, we separate the local and transported smoke effects for our exposure estimates. Across the low-cost sensor network, 24-hour mean $PM_{2.5}$ increased by 5.2 $\mu g/m^3$ on days impacted by smoke from fires in the eastern Kansas region versus smoke-free days. We compared our findings to two products derived from multiple satellites and ground-based measurements. We observed an increase in $PM_{2.5}$ concentrations in the Flint Hills in both satellite products and in-situ measurements during the prescribed burning period.

2SS.5

Large Variability in Ambient Fine Particle pH in Fairbanks Winter. JAMES CAMPBELL, Michael Battaglia, Kayane Dingilian, Meeta Cesler-Maloney, William Simpson, Ellis Robinson, Peter F. DeCarlo, Brice Temime-Roussel, Barbara D'Anna, Jack Dibb, Athanasios Nenes, Rodney J. Weber, Jingqiu Mao, *University of Alaska Fairbanks*

Fairbanks, Alaska is a subarctic city with fine-particle (PM2.5) concentrations that often exceed air quality regulations in winter due to poor dispersion caused by strong temperature inversions coupled with large local emissions and unique chemistry occurring under cold and dark conditions. The average temperature during the study was -18°C but reached -35°C during a pollution event. Many of the processes that contribute to severe air pollution in this climate are not yet well understood. Particle pH is a major concern because pH affects many secondary processes that can increase the overall PM mass concentration, alter its chemical composition, and contribute to its toxicity. Here, we use a comprehensive dataset of aerosol particle and gas measurements from the Alaska Layered Pollution And Chemical Analysis (ALPACA) campaign, combined with a thermodynamic model (ISORROPIA II), to examine pH in ambient PM2.5. We find that pH shows a bimodal distribution, where it is either relatively high (3 to 5) or low (-1 to 1). This pH bifurcation is largely due to the volatility of ammonium (the main base), but not sulfate (the main acid). The volatility of ammonia drops with decreasing temperature and raises the pH at which NH3(g)/NH4+(aq) buffers, whereas the buffering pH range of HSO4-(aq)/SO42-(aq) is low regardless of temperature. This makes particle pH in Fairbanks highly sensitive to the total ammonium to total sulfate ratio (TA/TS) to a degree not observed at more moderate temperatures. Frequent periods of sufficiently high pH in Fairbanks to support aqueous formation of hydroxymethanesulfonate, which requires a pH of 4 to 5, is predicted to result from this behavior, in agreement with observations. Overall, these findings show that aerosol particle pH in very cold environments behaves in a unique way that modulates particle composition and affects air quality.

2SS.6

Preliminary Indoor PM2.5 Data from the Whole Communities—Whole Health Pilot Study. ANSEL EARLY, David Jarma, Atila Novoselac, Kerry Kinney, *The University of Texas at Austin*

Real-time PM2.5 data were collected from 20 households over the course of 2022 using low-cost sensors as part of the pilot study for The University of Texas at Austin Whole Communities—Whole Health Project. The PM2.5 sensors were previously calibrated using reference grade equipment. Data were taken with a 1 minute sample rate over multiple day intervals in each household. Temperature, humidity, and carbon dioxide concentrations were simultaneously collected, providing simultaneous proxies for ventilation rates and HVAC operation. Additionally, compositional data were obtained from concurrent floor dust samples. Data from this pilot study provide an estimate of the average PM2.5 exposure to members of the household, as well as insight into the time varying behavior of indoor PM2.5 concentrations under real-world conditions, including the relative PM2.5 concentrations between indoor and outdoor environments and possible impacts of home HVAC systems on indoor PM2.5 concentrations. Additionally, these data provide a real-world test for the efficacy of using low-cost optical particle counters to determine indoor particle exposures.

2SS.7

Enhanced Measurements of PM2.5 Chemical Composition and Size Distribution in Wilmington, CA. JULIA MONTOYA-AGUILERA, Christopher Lim, Mohammad Sowlat, Steven Boddeker, Zihan Zhu, Sina Hasheminassab, Roya Bahreini, Nga Lee Ng, Payam Pakbin, Andrea Polidori, Jason Low, *South Coast Air Quality Management District*

The South Coast AQMD has undertaken several Environmental Justice (EJ) initiatives, such as CA Assembly Bill 617 (AB 617), conducting enhanced air monitoring to help reduce the impact of air pollution on disproportionately burdened communities. Wilmington, CA is part of an AB 617 designated community and is in close proximity to a variety of air pollution sources (e.g., major refineries, oil and gas facilities, ports of Los Angeles and Long Beach, and major roadways), complicating mitigation efforts. As part of a U.S. EPA American Rescue Plan grant, South Coast AQMD will establish an advanced PM2.5 monitoring station in Wilmington to better understand the formation and composition of PM in this community. The proposed suite of instruments will be capable of online analysis of PM composition (i.e., carbonaceous compounds, trace metals, ions, and organics) and size distribution with hourly or sub-hourly time resolution. The station will be complementary to the Atmospheric Science and mEasurement NeTwork (ASCENT), which currently has two additional advanced monitoring stations in the South Coast Air Basin (SCAB) in Pico Rivera and Rubidoux. These stations provide similar measurements, enabling comparisons between sites with distinct characteristics and different emission sources. This, in turn, will enhance our understanding of the evolution of PM across the Basin. These detailed measurements of PM composition will inform more effective and targeted policies to reduce emissions that will ultimately lead to better air quality in the SCAB. Here, we will introduce the scope, timeline, and main objectives of the project, and discuss how this project ties in with the previous work conducted in the area by South Coast AQMD and collaborators. We will also provide detailed information about the Wilmington community, nearby emissions sources, and instrumentation to be used as part of this project.

2SS.8

Air-Microfluidic Resonator-based Aerosol Sensors: Pitfalls and Opportunities. IGOR PAPROTNY, Mandana Hajizadehmotlagh, Dorsa Fahimi, Anuj Singhal, *University of Illinois at Chicago*

In this work we will summarize over a decade's worth of work on the research conducted at the Air-Microfluidics Group (AMFG) on developing air-microfluidic resonator-based real-time gravimetric PM mass sensors. The applications developed used microelectromechanical systems (MEMS) technologies to fractionate and deposit aerosols onto acoustic resonators. We present the advantages and pitfalls of using these approaches for measuring concentrations of airborne PM at various sizes in handheld applications, in particular compared to optical detection methods. We will then present our most recent work, developing gravimetric MEMS PM sensors using 2-photon stereolithography, and show their applications to novel types of optimized low-cost MEMS aerosol sensors.

2SS.9

Long-term Fine-scale PM2.5 Source Impacts from Major Sources at Monitors across the US. TING ZHANG, Lucas Henneman, *George Mason University*

Background. Epidemiological evidence has shown differing adverse health impacts of source-specific ambient fine particles ($PM_{2.5}$). Spatiotemporal variability in $PM_{2.5}$ source impacts is not measured, warranting the development of consistent approaches to quantify source impact fields across large spatial-temporal domains.

Methods. Our study aimed to estimate the daily $PM_{2.5}$ source impacts at monitors during 2011-2020 across the US. $PM_{2.5}$ species data from >300 monitoring sites were extracted from two monitoring networks, the Interagency Monitoring of Protected Visual Environments (IMPROVE) and the Chemical Speciation Network (CSN). After comparing the flagged and unflagged $PM_{2.5}$ species concentrations, we removed those with unacceptable flags and refilled them after evaluating the performance of four interpolation methods. We clustered monitoring sites separately in two networks with a random forest (RF)-based method. Finally, we carried out multi-site dispersion-normalized positive matrix factorization for daily estimates of $PM_{2.5}$ source impacts from a consistent list of sources. Single-site source apportionment was conducted to validate the results from multi-site analyses.

Results. We found that CSN and IMPROVE datasets required refilling for 3.40% and 2.85% of the data, respectively, with higher rates (>5%) for carbonaceous substances. For $PM_{2.5}$ species concentration interpolation, the RF-based method had the lowest normalized root mean squared error (0.37±0.05) and outperformed others. Monitoring sites from CSN and IMPROVE networks were grouped into 25 clusters each to resolve primary sources, including gasoline vehicles, diesel vehicles, and biomass burning, for individual clusters and monitors. For example, in a site in Los Angeles, the estimated contributions of the above sources were 3.07%, 13.9%, and 16.0%.

Conclusion. The varied techniques over time at CSN and IMPROVE networks make it challengeable to quantify source impacts nationwide under a consistent framework. Here we identified strategies to streamline this process. Our results have the potential to advance source-specific epidemiology, environmental justice, and regulatory accountability studies.

2SS.10

Aerosol Size Distribution Comparison of Volcanic Ashes and Sahara Dust and Its Spatial Differences on La Palma Island.

VOLKER ZIEGLER, Maximilian Weiss, Frederik Weis, Henrik Hof, Ann Katrin Grossmann, Jon Vilches Sarasate, Agnes Sauleda Brossa, *Palas GmbH, Karlsruhe, Germany*

Dust monitoring is an important part of climate research. Its deposition on snow and glaciers for example intensify melting and dust also influence other atmospheric conditions that are related to climate change. In addition to this it also affects people's health as deposition in the human lung can cause respiratory diseases. This wide range of effects leads to a major interest in aerosol measurements for large group of researchers. One factor of interest is the transport of dust in the atmosphere. To study this, 9 aerosol AQ Guard Smart Aerosol Spectrometers have been installed on la Palma Island during the volcano eruption in Autumn/Winter 2021.

The devices were installed around the volcano with focus on the most affected areas but also on the far side of the mountain chain dividing the island in east and west part. Aerosol size and number concentration as well as particulate matter values were measured from mid of November until mid-February thus covering a period with Volcanic activities (until 13.12.2021) and without. Additionally, we also captured two days of airborne Sahara Sand dust washing over the Canary Islands.

Local differences in particulate matter readings

The local differences in particulate matter during the volcano eruption were studied with the data obtained from the 9 devices and found to vary depending on wind conditions. Especially the difference between the east and west site of la Palma was found to be very pronounced which is in accordance with the island being divided by a mountain chain.

Differences in aerosol composition

The particle size distribution of the aerosol during the volcano eruption (= airborne volcanic ashes) and the Sahara Sand Dust event (= airborne sand dust) can be found in Figure 1 together with an exemplary size distribution of normal ambient air at the same location. While sand dust influences the whole captured particle size range, volcanic dust is found to be much coarser.

References:

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2SS.11

Global Simulations of Phase State of Secondary Organic Aerosols with GEOS-Chem.

REGINA LUU, Meredith Schervish, Nicole June, O'Donnell Samuel, Shantanu Jathar, Jeffrey R. Pierce, Manabu Shiraiwa, *University of California, Irvine*

Secondary organic aerosols (SOA) phase states have strong implications for aerosol effects on climate and air quality. The phase state of SOA particles informs SOA formation and partitioning, multiphase chemistry, and ice nucleation. Glass transition temperature (T_g) denotes a nonequilibrium phase state change from a solid to a more malleable semi-solid state as temperature increases. Regional modeling studies over the contiguous US have shown that SOA in the western US has higher surface T_g and SOA viscosity compared to the eastern US, resembling geospatial relative humidity patterns. On the global scale, SOA is predicted as mostly liquid in tropical and polar air with high relative humidity, semi-solid at the mid-latitudes, and solid over arid lands . However, most large-scale climate models do not intrinsically account for SOA phase state and its consequences on gas-particle partitioning. Here, we aim to implement SOA phase state prediction methodology into the global transport model GEOS-Chem to evaluate spatial-temporal variations in the atmosphere. We use the volatility basis set (VBS) and molecular corridors to assign molar mass and O:C ratios of organic compounds to estimate T_g. The prediction of SOA viscosity was derived from the Angell plot of fragility while considering the Gordon-Taylor mixing rule and hygroscopic growth of SOA particles. Our results suggest agreement with previous findings on the global distribution of SOA phase states. Then sensitivity studies varying assumed O:C and the hygroscopicity parameter by +/- 50%, indicate a significant dependence of T_g on the hygroscopicity parameter but minimally on O:C. Although initial results presented here are from offline calculations, with an online integration of SOA phase state predictions, large-scale models like GEOS-Chem can have more comprehensive evaluations of global atmospheric aerosol processes and the impacts on air quality, public health, and the climate.

2SS.12

Investigating the Impact of Emission Reductions on Ambient PAH and Nitrated PAH Concentrations. JUN MENG, Elisabeth Galarneau, Deyong Wen, Junhua Zhang, Kenjiro Toyota, Verica Savic-Jovcic, *Environment and Climate Change Canada*

Polycyclic aromatic hydrocarbons (PAHs) are hazardous air pollutants with potential health impacts, and nitrated PAHs (nitro-PAHs) are known to exhibit even higher toxicity. However, there has been limited research on how the spatial concentrations of PAHs have changed over time. In this study, we investigate the impact of decreasing emissions on ambient PAH and nitro-PAHs concentrations over the past two decades using a regional chemical transport model with high horizontal resolution.

We implement a new nitro-PAH species, 2-Nitrofluoranthene (2-NFLT), into the widely used Global Environmental Multiscale model – Modelling Air quality and CHemistry (GEM-MACH). We evaluate the performance of the model by comparing model predictions with available measurements of 2-NFLT concentrations in ambient air collected within the model domain. By simulating 2-NFLT concentrations for different emission levels over a span of three decades, we aim to identify the changes in 2-NFLT concentrations compared to primary PAH concentrations and quantify how emissions from traffic sector contribute to 2-NFLT concentrations.

Overall, our study emphasizes the importance of fine spatial resolution in nitro-PAH modeling and provides valuable insights into the co-benefits of reducing primary PAH emissions and NOX emission through emission reductions over the past two decades. The findings from this work can inform policy decisions regarding air quality improvement and public health protection.

2SS.13

Preliminary Results from the ASCENT Network: Aerosol Composition and Concentration at Cheeka Peak Observatory. OLIVIA HAKAN, Philip Rund, Olga Garmash, Odelle Hadley, Courtney Winck, Nga Lee Ng, Ann Dillner, Roya Bahreini, Armistead G. Russell, Joel A. Thornton, *University of Washington*

The Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT) is a recently developed network that measures aerosol concentration and composition across the US. The 12 ASCENT sites continuously monitor aerosol concentration and speciation in near real time. Each site has been equipped with an aerosol chemical speciation monitor (ACSM), an aethalometer (AE33), a Xact multi-metals monitor (Xact625i), and a size mobility particle scanner (SMPS). These instruments measure non-refractive mass loading and composition, light-absorbing particle concentration, metal concentrations of 46 different species, and the total particle concentration and size distribution, respectively. The University of Washington’s field site, Cheeka Peak Observatory, is located on the Olympic Peninsula, roughly 75 miles from the nearest city of Port Angeles and less than 5 miles from the pacific ocean. In this poster, we show preliminary results from six months of combined sampling. Over this period, particle size distributions measured by the SMPS have exhibited a number-weighted median particle diameter of 66 nm and an average total particle number concentration of 830 particles/cm3 (ranging from <100 to >4440 particles/cm3). The AE33 has measured an average of 0.03 µg/m3 of black carbon, with values ranging from 0 - 1.2 µg/m3. And the ACSM has shown that non-refractory fine mode particle mass at the CPO field site is primarily dominated by organic and sulfate aerosol species with mean speciated mass concentrations of 0.03 (chloride), 0.05 (ammonia), 0.03 (nitrate), 0.24 (sulfate), and 0.22 (organic) µg/m3. This data set also includes episodic organic aerosols from smoke and forestry-related practices, new particle formation from both marine and terrestrial sources, and evidence of heavy metals from maritime vessel traffic.

2SS.14

Spatial and Temporal Variabilty in PM2.5 in NAPA Valley, CA August-October 2020. WILLIAM MILLS, Justin Cathey, *Northern Illinois University*

The LNU Lightning Complex (August 17-October 2, 2020) and Glass (September 27-October 20, 2020) Fires burned during the 2020 California wildfire season. A total of 23 PurpleAir stations were identified in Napa Valley with $PM_{2.5}$ monitoring data for at least part of the August 1-October 31, 2020 time period. $PM_{2.5}$ data (10 minute and daily average, uncorrected and corrected using a US EPA correction factor) from these stations were analysed to provide information on spatial and temporal variability of the $PM_{2.5}$ during this time period and to assess the impact from these fires on local air quality. Noticeable elevations (attributed to the LNU Lightning Complex Fire) were seen for some stations, in mid-August, end of August and mid-September, however peak levels during these time periods were significantly less than those observed at most stations during the Glass fire. Correlation analyses showed excellent agreement (high R^2 and slope=1) between adjacent monitoring locations during the Glass Fire. These same analyses showed well-correlated but lower concentrations further from the fire for the initial 3-4 hrs (0300-0700 hrs) after which the Napa Valley sites all plateaued at approximately the same high $PM_{2.5}$ levels (100-300 ug/m^4) but dropped in mid-day until early evening time period and then became elevated again at many locations. These trends are consistent with the eye witness descriptions and aerial imagery of the Glass Fire footprint and behaviour over the first day. Estimates of $PM_{2.5}$ concentrations on a property near the source were made based on regression analysis of $PM_{2.5}$ versus distance from the nearest station. Heatmap data visualization was used to show the $PM_{2.5}$ concentrations in Napa Valley for several time points. This analysis work illustrates the utility of the PurpleAir monitoring network for observing impacts from wildfires on local air quality.

2UA.1

Properties and Chemistry of Ultrafine Particles at Zurich Airport. Zachary Decker, Peter A. Alpert, Jay G. Slowik, Michael Bauer, Markus Ammann, Lukas Durdina, Jacinta Edebeli, Curdin Spirig, André S. H. Prévôt, Julien Anet, Martin Gysel, BENJAMIN BREM, *Laboratory of Atmospheric Chemistry, Paul Scherrer Institute*

Aviation emission impacts on ground-level Ultra Fine Particle (UFP) number concentrations have been identified to be significant over extensive areas near airports and along flight paths under certain meteorological conditions. For example, significantly elevated PN concentrations were reported as far as 7 km and 22 km downwind of the Amsterdam Schiphol and London Heathrow airports, respectively . A rapid evolution of aerosol properties within the fresh aircraft engine plume takes place involving coagulation as well as nucleation and condensation of semi volatile species. Therefore, an assessment of aviation emission air quality impacts requires not only a detailed understanding of the emissions at the engine exit plane, but also a comprehensive and mechanistic understanding of the evolving chemical and physical processes in the plume.

As part of the Aviation Plume PROPeRtIes AT point of Exposure (APPROPRIATE) research campaign, we carried out laboratory, engine test site, and airport ambient field measurements with a comprehensive suite of physical and chemical gas- and aerosol-phase instrumentation. The chemical measurements included VOCUS Proton Transfer Reaction Time of Flight Mass Spectrometry (VOCUS PTR-ToF-MS), Extractive Electrospray Size Selected Ionization ToF-MS (EESSSI-ToF-MS) and an Aerosol MS (AMS).

We will show that field results confirm the utility of the chemical tracers identified in our laboratory studies. Interestingly, markers for fresh oil were not detected, even in newly overhauled engines, suggesting aircraft oil emissions undergo significant chemical change after first use. In contrast, chemical markers of used oil and commonly known oil components (e.g. tricresyl phosphate) were detected at both the test cell and field site. Ambient measurements detected several individual aircraft UFP plumes and many oil markers and we will discuss the efforts to quantify them in the context of airport operations.

2UA.2

Influence of Multiphase Chemistry on Oxygenated Organic Aerosol Formation in the New York City Region. MITCHELL ROGERS, Taekyu Joo, Tori Hass-Mitchell, Benjamin A. Nault, Mia Tran, Manjula Canagaratna, Joseph Roscioli, Jordan Krechmer, Andrew Lambe, Drew Gentner, *Yale University*

Aqueous-phase uptake and processing of water-soluble organic compounds contributes significantly to atmospheric secondary organic aerosol (SOA) with variations between regions. Current models predict that changes in climate and emissions will lead to increases in hygroscopic inorganic aerosol components and aerosol liquid water content that may further promote the relative importance of aqueous processing pathways. Using summer 2022 observations in New York City from the NYC-METS (New York City metropolitan Measurements of Emissions and TransformationS) campaign and ASCENT (Atmospheric Science and Chemistry mEasurement NeTwork), we evaluate the influence of aqueous-phase aerosol processing on ambient SOA across two different field sites in New York City. Two Aerodyne aerosol chemical speciation monitors (ACSM) were deployed with supporting measurements of black and brown carbon and reactive gases (e.g., NO_x, O_3, SO_2) at an elevated rooftop site in densely populated Manhattan, NY and a long-term monitoring site in Queens, NY. Using these measurements, we evaluate changes in aerosol production and composition as a function of changes in relative humidity and aerosol liquid water content. Variations in sulfate and other environmental factors at the two sites are examined for their influence on oxygenated organic aerosol (OOA), which is separated into less and more oxidized aerosols using source apportionment of ACSM measurements. The relative role of aqueous-phase processing varied with meteorological conditions, with clear OOA enhancements (e.g., 1+ $\mu g/m^3$) during several hot and humid periods highlighting the important, yet variable, role of aqueous-phase SOA production. The less oxidized OOA identified in the less densely populated Queens, NY site showed the strongest sensitivity to temperature, humidity, and sulfate. These results and the sensitivity to climate are interpreted within the context of our current understanding of summertime aerosol abundances and dynamics and their role in New York City and downwind air quality.

2UA.3

Multi-Year Datasets of PM1 Chemical Composition and Organic Aerosol Sources at Various French Urban and Suburban Areas. HASNA CHEBAICHEB, Olivier Favez, Joel Brito, Florian Couvidat, Augustin Colette, Caroline Marchand, Veronique Riffault, *Laboratoire Central de Surveillance de la Qualité de l'Air*

In France, exposure to fine particles (PM) is responsible for 48000 premature deaths per year. PM concentrations exceed the annual PM2.5 concentration of 5 µg.m-3 recommended by the WHO (EEA, 2021). In this context, more than 12 ACSMs (Aerosol Chemical Speciation Monitor) and aethalometers (AE33) have been operating quasi-continuously since 2015 at different French urban sites. The objective is to provide a long-term dataset of the chemical composition of PM1 particles and to study the sources of organic aerosols (OA) by applying the rolling Positive Matrix Factorization method. This approach, based on relevant constraints and criteria, has the advantage of capturing potential temporal changes in source profiles within multi-year datasets.

The results of this study first confirm that OA is the main component of submicron aerosol in many French cities (40-60% of PM1). Spatial variability in the chemical composition and OA sources is also observed. Primary factors are mainly related to combustion processes. In particular, hydrocarbon-type OA (related to traffic, HOA) and that from biomass combustion (BBOA) are present at all sites. The HOA factor shows a fairly constant contribution to the OA throughout the period while the BBOA factor varies with a peak in winter due to increased emissions from residential wood burning. Other site-specific primary sources were also resolved, including those related to cooking, as well as port and/or industrial emissions. Oxygenated factors were distinguished between their less and more oxidized fractions (LO-OOA and MO-OOA, respectively). These oxygenated factors dominate the OA at all sites, with an average contribution of 74%, suggesting a very strong contribution from aging and secondary formation processes. Comparison with the CHIMERE model and with filter-based aerosol tracers is also considered to improve our knowledge of OA sources in France and may help improve the accuracy of air quality models.

Acknowledgments
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2UA.4

Exposure of City-Dwellers to Particulate Matters during Commuting Trips in the Metropolitan Area of Karachi.

KAMRAN KHAN, Haider Khwaja, Sumayya Saied, Saiyada Masood, *University of Karachi, Pakistan*

This study provides the missing knowledge on the commuter's exposure to PM in a megacity of the world seeing unprecedented growth in population, urbanization, traffic, and air pollution. Extensive sampling campaigns of real-time size-segregated PM (PM1, PM2.5, PM7, PM10 and TSP) were carried out to assess commuter's exposure to these pollutants by seven diverse routes in the highly urbanized city of Karachi. The findings strongly indicate that commuters in Karachi were exposed to extremely high PM concentrations than many cities in the developed world. Size-fractions of PM revealed substantial intra-route and inter-route variability, indicating that PM may be dependent on many factors such as route topography, building and road layouts, extent of emissions, mixed fleet, distance from traffic, passage through intersections, traffic conditions, traffic densities between routes, vehicle speed, trip duration, and meteorological conditions. Results suggest that the highest trip average concentrations occur on the route (Route-5) connecting the industrial corridor and the commercial area. The PM1/PM2.5 and fine/coarse (PM2.5/PM10) ratios of all routes ranged 0.13 – 0.25 and 0.08 – 0.14, respectively, suggesting that traffic emissions were the cause of high PM. Karachi's characteristic roadside sources (e.g., restaurants, outdoor barbecuing, cigarette smoking, resuspension of the dust, and construction activities) contributed to high PM. The PM2.5 inhalation dose was high (1.1 – 3.2 µg/km). The inhalation cancer risk associated with the exposure of PM2.5 exceeded the US EPA benchmark of 10-6 - 10-4. As this study is the first to extensively analyze commuters' exposure, further research is needed by local and federal authorities to implement effective mitigation strategies towards better air quality in Karachi, Pakistan.

2UA.5

Use of an Oxidation Flow Reactor in the Field to Study Ambient Secondary Aerosol Formation from Gas- and Aqueous-Phase Chemistry.

YING ZHOU, Alexander B. MacDonald, Ningjin Xu, Xuanlin Du, Roya Bahreini, Don Collins, *University of California, Riverside*

An oxidation flow reactor (OFR) was employed to study the gas- and aqueous-phase chemistry that leads to secondary aerosol (SA) formation in ambient air. The Accelerated Production and Processing of Aerosols (APPA) reactor with a Perfluoroalkoxy Alkane (PFA) Teflon flow tube has been redesigned to achieve portability for field experiments. The project aims to develop an effective approach to mitigate emissions from different sources sufficiently to meet federal standards for the two major criteria air pollutants: O_3 and $PM_{2.5}$. The project involves 4-week field studies at sites in Riverside, CA (October 2022), Wilmington, CA (March 2023), and Bakersfield, CA (planned for winter, 2024). Riverside represents the Inland Empire region of southern California where prevailing westerly winds frequently bring high PM and is also notably influenced by emissions from the goods movement industry, while Wilmington and Bakersfield are significantly impacted by port and truck emissions, and energy and agricultural production, respectively. A Scanning Mobility Particle Sizer (SMPS) and a compact time of flight mini Aerosol Mass Spectrometer (mAMS) are used to sample the processed air exiting the APPA reactor. To investigate the effect of OH exposure and liquid water content on SA formation, OH exposure over the average reactor residence time of ~150 s was varied from $\sim 1 \times 10^{11}$ to $\sim 5 \times 10^{11}$ molec cm^{-3} s by changing the externally added O_3 concentration, while relative humidity (RH) inside the APPA reactor was cycled between 40%, 85% and 100%, for which dry seed aerosol, aqueous seed aerosol and cloud droplets were present in the reactor, respectively. Organic aerosol (OA) concentration generally increased with OH exposure and with aerosol/droplet water content. In addition, OA concentration was higher at nighttime than during the day, presumably because of accumulation of reactive precursors in the absence of ambient photochemistry.

2UA.6

Organic Components Containing Sulfur and Nitrogen Reduce the Volatility of Urban Organic Aerosols. QIAORONG XIE, Alexander Laskin, Pingqing Fu, *Purdue University*

Size-segregated samples of atmospheric organic aerosol (OA) in the urban area of Beijing were collected near the ground surface (8 m) and at 260 m above the ground provided by a meteorological tower. The OA samples were analyzed by ultrahigh-resolution Fourier transform-ion cyclotron resonance (FT-ICR) mass spectrometry with electrospray ionization source operated in negative mode. Substantial contributions of oxygenated organics, organosulfates and nitrooxy-organosulfates with broad range of molecular weights were detected in all samples. Assessment of the aerosol volatility representative of the size-segregated samples was performed. The results show that collected OA samples were dominated by extremely low, ultralow, and non-volatility organic compounds, and their volatility decreases with particle size, particularly at the episodes of severe air pollution. During the haze events, OA samples collected at 260 m height in the urban boundary layer contained more aged, lower volatility, species likely formed throughout regional transport, than those found in the ground-level OA samples. The reactions of oxygen-containing compounds with sulfur dioxide and nitrogen oxides resulted in formation of much low volatility products with nitrooxy-organosulfates being the most non-volatile components. We estimate for the first time the vapor pressure changes with the presence of organosulfates and nitrooxy-organosulfates in size-segregated aerosol particles. Our study demonstrates the importance of these low-volatility organic compounds in the urban boundary layer, which is crucial for modeling their physicochemical properties and ageing evolution in troposphere.

2UA.7

Identifying Mass Spectral Markers for Tire Wear Particles. XING WANG, Arthur W. H. Chan, Greg J. Evans, *University of Toronto*

Non-exhaust particles are a major source of primary particulate matter emission from traffic, and their contribution is growing. These particles arise from the wear of brakes, tires, and road surfaces, are unregulated in North America, and now estimated to exceed exhaust particulate matter emissions in many jurisdictions. Apportioning the contribution of non-exhaust emissions to ambient particulate matter concentrations is challenging due to the lack of appropriate tracers for each non-exhaust component. Metal markers have previously been used based on the material composition and scaling factors, but this approach is limited for tire wear particles since markers like Zn can originate from other sources. Here, we develop methods to characterize tire wear particles using online aerosol mass spectrometry and offline pyrolysis-gas chromatography-mass spectrometry, with the aim of identifying robust mass spectral markers to estimate the contribution of tire wear particles to ambient particulate matter. We analyzed submicron tire wear particles generated using a diamond burr sander attached to Dremel rotary tool and cryogenically-milled tire tread particles. We observed hydrocarbon-like organic aerosol and ions corresponding to tire tread additives. This combination of ions may be useful as markers to resolve the contribution of tire wear particles in near roadway environments.

2UA.8

Effect of Secondary Organic Aerosol Formation Pathways on Human Health. LU QI, Ka Yuen Cheung, Chuan Ping Lee, Dongyu S. Wang, Zhiyu Li, Weikang Ran, Yufang Hao, Xinmei Huang, Gang Chen, Qingqing Wang, Weiqi Xu, Tianqu Cui, Kun Li, Vishal Verma, Yuemei Han, Qiyuan Wang, Zifa Wang, Yele Sun, Kaspar R. Daellenbach, Urs Baltensperger, Robin Modini, Imad El Haddad, Junji Cao, André S. H. Prévôt, Jay G. Slowik, *Paul Scherrer Institute*

Atmospheric aerosols are among the largest global environmental risks to public health and responsible for considerable uncertainty in the climate system. Much of this uncertainty is due to secondary organic aerosol (SOA), which consists of thousands of multifunctional, oxygenated species that are difficult to measure in situ. In consequence, source apportionment studies typically treat SOA as a single bulk quantity (or as a linear combination of non-source-specific vectors), and the effects of specific SOA sources and on human health and climate effect remain poorly constrained.

Here we utilize extractive electrospray ionization coupled to time-of-flight and orbitrap mass spectrometers (EESI-TOF and EESI-Orbitrap) to elucidate wintertime SOA sources and formation pathways in Beijing, China. High-RH conditions with widespread cloud formation are typical of severe haze events in Beijing, yielding high aerosol liquid water content (LWC) and thereby favoring aqueous-phase reactions. We identify two factors related to aqueous SOA production, one of which (AqSOA) is characterized by small, highly oxygenated molecules and depends mainly on LWC. The second aqueous factor (AqSOA_AMN) is related to both LWC and NH_3^+/NH_4^+, and shows enhancements from N-containing molecules consistent with imidazoles, which are known to be formed from aqueous reactions of glyoxal in the presence of NH_4^+-containing seed. The AqSOA_AMN factor also exhibits far higher oxidative potential (OP) on a per mass basis than either AqSOA, or aged biomass burning. Further, during pollution events conducive to its formation, AqSOA_AMN has considerable effects on both the SOA-derived and total OP. This highlights the implications of different SOA pathways, including NH_3/NH_4^+- mediated aqueous chemistry, for human health. More generally, we demonstrate that the SOA contributions to oxidation potential (OP) are both considerable and strongly source-dependent and highlight the shortcomings of treating SOA as a bulk or non-source-specific quantity.

2UA.9

Elemental Characterization of PM2.5 at an Urban Traffic Site in Central Europe. Laurence Windell, Jaroslav Schwarz, Radek Lhotka, Petra Pokorná, Jakub Ondráček, Vladimír Ždímal, PHILIP K. HOPKE, *ICPF CAS, Prague, Czech Republic*

Metal content in traffic emissions is often overlooked during regulation and policy making. Exhaust and non-exhaust traffic emissions, including tire, brake wear and re-suspended dust, contribute greatly to particulate matter and pose significant adverse health effects to humans in urban areas (Johansson et al., 2009). The current lack of strict regulations on these metal emissions draws attention to the need for controls and monitoring, as reflected in the recent Euro 7 standards proposal for research on traffic emissions. This work aims to quantify metal emissions from traffic at an urban traffic site in Prague, Czech Republic, identify key tracers of emissions, and investigate exhaust and non-exhaust emissions observable in fine particulate matter (PM2.5). This project signifies the first high-time resolution metal analysis in Prague.
Two one-month long measurement campaigns were conducted from February to March and November to December 2020 at an urban traffic site in Prague. Elemental data were obtained from the Xact625i Ambient Metals Monitor (analytical method nondestructive energy dispersive X-ray fluorescence – EDXRF) equipped with a PM2.5 sampling head at a two-hour time resolution. Enrichment factors were calculated, and correlations of key tracers (e.g. Cu, Ba, Zn, Mn) were identified. Source apportionment was carried out using Positive Matrix Factorization (US EPA PMF 5.0). Four factors were identified: dust, traffic, local heating, and coal burning. Metallic elemental concentrations were observed in decreasing order: Fe > Zn > Cu > Ti > Mn > Ba > Cr > As > Cd > Ni. The most abundant metal, Fe, was found in the range of 10 – 2933 ng/m3, followed by Zn (1 – 144 ng/m3), Cu (1 – 104 ng/m3), Ba (0.1 – 41 ng/m3) and Cr (0.2 – 16 ng/m3). Enrichment factors of Mn, Cr, and Cu and Zn were found to be up to 71, 113, 1066, and 1937, respectively.

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2UA.10

Chemical, Physical, and Optical Properties of Ambient Particulate Matter during Widespread Fireworks Use in Southern California. DANIEL B. CURTIS, Danielle Rocco, Esther Morales, Jason Truong, Tyler Deflin, *California State University, Fullerton*

Chronic and acute exposure to particulate matter has been linked to an increased risk of adverse health effects in humans. Within the Los Angeles basin, one of the worst annual air quality days is the July 4 holiday, when sanctioned and personal use of fireworks is prevalent and $PM_{2.5}$ concentrations approach 300 µg m^{-3}. Fireworks emissions are especially concerning because the particles contain potentially harmful metals that are used in salts to produce the varied colors seen during fireworks explosions.

This study investigated air quality during July 4th, 2020, and 2021 in Fullerton, California, located in the Los Angeles metropolitan area. Ambient concentrations of the selected metals barium, chromium, copper, lead, and strontium were measured by collecting particles on filters, extracting, then analyzing with atomic absorption spectroscopy. In 2021, barium, copper, and strontium peaked on the night of July 4-5, with concentrations of 1761 ng m^{-3}, 1472 ng m^{-3}, and 668 ng m^{-3}, respectively. Chromium and lead concentrations varied, indicating that they may be controlled by factors other than fireworks in this location.

Submicrometer particle size distributions were measured using a Scanning Mobility Particle Sizer (TSI, Inc.) and aerosol optical properties were measured using a Cavity Attenuated Phase Shift Spectrometer (PM_{ex}, Aerodyne) at a wavelength of 450 nm and an Integrating Nephelometer (2-WIN, Ambilabs) at wavelengths of 450 nm and 525 nm. In addition, two PurpleAir sensors (one outdoor and one indoor) were deployed and compared. The real and imaginary refractive indices of the aerosol were retrieved using Mie theory and were variable, with an effective real refractive index of approximately 1.75 and an effective imaginary refractive index of 0.05 at a wavelength of 450 nm, indicating that the particles were slightly absorbing.

2UA.11

Assessing the Spatial Distribution of Traffic-Related Lung Deposited Surface Area in an Urban Micro-Environment Using Computational Fluid Dynamics. PO-KAI CHANG, Li-Ti Chou, Ta-Chih Hsiao, *National Taiwan University, Taiwan*

In urban areas, traffic emission is a major contributor to particulate matter (PM), especially ultrafine particles (UFPs). The health impact of UFPs (particle size smaller than 100 nm) has been increasingly recognized because of their large number concentration and total surface area. Lung deposited surface area (LDSA) is defined as the total surface area of the particles deposited in the lung (a function of particle size) that has been argued to more accurately predict health effects from PM exposure. This study investigated the LDSA emitted from traffic sources in a Taiwan urban area and its potential health impacts, with a focus on UFPs. Field measurements revealed that traffic-related LDSA accounted for 63.5% of total LDSA, with a concentration of 28.1 ($\mu m^2/cm^3$). The study employed computational fluid dynamic (CFD) simulations to assess particle transmission and their health impacts. The gradient of LDSA concentration in the surrounding microenvironment was evaluated based on the simulation results, which showed that the spatial distribution of concentration was strongly affected by urban geometric structure. The high concentration were found in major traffic roads and the flow vortex positions. Generally, when the distance from the pollution source increased, the concentration would gradually decrease. Additionally, the study assessed the excess lifetime cancer risk (ELCR) associated with exposure to UFPs. This study provides important insights into the impacts of traffic-related air pollution on human health, and highlights the importance of addressing this issue through evidence-based policy interventions and sustainable urban planning.

2UA.12

Within-City Variability of Ultrafine and Fine Particulate Matter in South Asian and North American Cities.

PROVAT SAHA, Tanbhir Shovon, Dipika Roy Prapti, Albert Presto, Allen Robinson, *Bangladesh University of Engineering and Technology*

In this study, we investigated the within-city variability of fine particle mass (PM2.5) and ultrafine particle number concentration (PNC) in Dhaka, Bangladesh, and Pittsburgh, USA, two cities with vastly different pollution sources and levels. We collected spatially dense co-measurements of PNC and PM2.5 at a wide range of sites spanning a variety of urban land use attributes (35 sites in Dhaka and 30 sites in Pittsburgh). We found that PNC levels exhibited a 3-4-fold variability between sites in each city, ranging from 20,000-100,000 # cm-3 in Dhaka and 7,000-28,000 # cm-3 in Pittsburgh. PM2.5 levels varied within 50% of the urban background level, ranging from 80-110 µg m-3 in Dhaka and 6-12 µg m-3 in Pittsburgh. We observed a moderate level of spatial correlation between PNC and PM2.5 measurements in both cities (R2 0.3 in Dhaka, and 0.4 in Pittsburgh), and consistent within-city spatial patterns in different seasons. Compared to the Pittsburgh levels, both PNC and PM2.5 levels in Dhaka were significantly higher, however, on a relative basis, PM2.5 was disproportionately higher (10-12 times higher) than PNC (3-4 times higher). The slope of PNC versus PM2.5 varied significantly between the two cities, suggesting that the sources and size distribution of particles that make up the majority of the PM2.5 mass were different in the two cities. Disproportionately higher PM2.5 levels in Dhaka are dominantly influenced by solid fuel combustion, including solid biomass burning, waste burning, and soil dust, which have a greater impact on particle mass concentration due to their larger size. In Pittsburgh, traffic (gasoline and diesel combustion) particles, relatively smaller in size compared to solid fuel combustion particles, likely play a dominant role in determining the within-city variability of PNC and PM2.5 mass.

2UA.13

Quantifying and Characterising Nanoparticle Emissions from Tyre and Road Wear Emissions.

MOLLY J. HAUGEN, Adam M Boies, *University of Cambridge*

On-road emissions are becoming dominated by tire and road wear emissions, creating a growing concern for non-combustion vehicles. The University of Cambridge is investigating online and offline tire and road wear particles (TRWPs) generated in laboratory settings, yet simulating real-world driving conditions, such as temperature, road surface, loads, and drive cycles. This work uses an ELPI+ (Dekati), a Catalytic Stripper (Catalytic Instruments), and a high-flow impactor (TSI Inc.) The results from this work allow the aerosol community to assess the key particle characteristics that must be maintained for for TRWPs used in toxicity and health studies.

Additionally, third body particles, an external source of particles, simulate real-world driving conditions further for laboratory settings and were optimised for nanoparticle assessment. Differentiating between third body particles and generated TRWPs is crucial for characterizing nanoparticles in real-world environments yet a difficult challenge and thus a main focus of this work. Here, a method to evaluate background nanoparticle concentration was determined, as well as individual assessment of the third body particles. It was also shown that managing legacy particles within laboratory settings will be key in TRWP emission testing and analysis.

2UA.14

Emissions of Nucleation Mode Brake Wear Particles on Real Urban Driving Cycles. HIROYUKI HAGINO, *Japan Automobile Research Institute*

In recently, a standard test method for measuring brake wear emissions for passenger cars was developed by the Particle Measurement Programme (PMP). This aim is to reproduce in a laboratory experiment a driving cycle based on the worldwide average braking pattern, with PM sampling and particle number (PN) measurements according to generally accepted methodologies. Although this method is the basis for future regulations, it is important to evaluate the chemical composition and physical properties on wide range real urban driving condition in order to assess environmental effects and health risks. In this study, brake wear particles derived from passenger car brakes were measured by reproducing urban driving based on brake dynamometer experiments. A genuine front brake system complying with the ECE-R90 standard was used for the passenger car brakes. Realistic driving patterns were used to observe the characterization of emission levels, particle size according to driving style, using the California Brake Driving Cycle (CBDC) and the Los Angeles City Traffic (LACT). Real-time particle size distribution of the nanoparticles was measured using a Fast Mobility Particle Sizer (FMPS3091, TSI). In this study, the nucleation mode particles were observed in events of high brake angular velocity (speed [rpm] and torque [Nm]) (i.e. high friction work [J]) measured with an axial torque meter and may not necessarily be explained by only brake temperature.
This study presents the results of nucleation mode particle emissions from passenger car brakes on a real driving cycle.
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2UA.15

Trends and Insights into Sources of PM2.5 in Kolkata, India from Low Cost Sensor Network Data. V. FAYE MCNEILL, Siddharth Nobell, Arnab Majumdar, Shovon Mukherjee, Sukumar Chakravorty, Sanjoy Chatterjee, Soumitra Bose, Anindita Dutta, Sandhya Sethuraman, Vigneshwari Sivakumar, Daniel Westervelt, Sarbani Palit, Shairik Sengupta, Rakhi Basu, *Columbia University*

We present results from two field-calibrated networks of low-cost ambient particulate matter sensors (LCS) in greater Kolkata, India operated between 2018-2019 and 2019-2021. In order to understand LCS performance in relation to local reference-grade PM2.5 monitors (RGMs) and to develop calibration functions, LCS were co-located with RGMs operated by the West Bengal Pollution Control Board at three locations. Data from the co-locations were used to calibrate the LCS network using random forest regression and multiple linear regression approaches. Measured relative humidity and temperature were significant model features. Cross-calibration between co-located LCS-RGM pairs was tested in order to demonstrate the strength of the field calibraiton approach. Seasonal diurnal trends and a high level of correlation across the hybrid LCS-RGM network suggest regional and secondary sources of PM2.5 dominate in Kolkata, despite significant local sources.

2UA.16

Climatology and Sources of Particulate Matter in an Urban Arid Region: First real-time chemical and elemental observations in Doha, Qatar. SHAMJAD MOOSAKUTTY, Mohammed Ayoub, Rami Alfarra, *Qatar Environment & Energy Research Institute*

Air pollutants in the Middle East region show unique characteristics due to the arid landforms, concentrated population center, and presence of Petrochemical industries. Naturally generated dust from the deserts dominates the overall atmospheric particulate matter (PM) under a 10µm size cutoff. However, anthropogenic sources significantly contribute to PM less than 2.5µm size cutoff, especially in population centers. Characterization and source identification of air pollutants is essential to develop mitigation strategies.

We present air pollutant data measured by the air quality monitoring network operated by the Qatar Environment and Energy Research Institute (QEERI). The QEERI air quality monitoring program started in early 2018 and operates six stations within the Greater Doha Area. The parameters measured include criteria pollutants and meteorological parameters. Since 2021, parameters such as black carbon, PMx mass, chemical composition, and metal concentrations have been added at selected stations. The black carbon concentrations were measured using dual-spot Aethalometers (AE-33), while the PM mass was measured under 1µm, 2.5µm, and 10µm using FIDAS. The chemical and metal concentrations were measured using a ToF-ACSM and Xact multi-metal analyzer.

The changes in air pollutant concentrations were studied using the daily, seasonal, and diurnal changes. The analysis shows seasonal changes in aerosol concentrations and sandstorms' effect on the overall air quality. The climatology of various aerosol species was identified for the wind speed and direction. The ACSM data shows regional sources for sulfate and organics, local sources for nitrate and organics, and secondary aerosol formations. During winter seasons, the nitrate concentrations peaked, indicating gas-to-particle partitioning. The metal concentrations measured by Xact show the dominance of silica, calcium, and sulfates. The source apportionment of the combined dataset was performed using the bilinear multilinear engine (ME-2) model. The analysis will help understand Doha's aerosol composition and sources to develop air pollution mitigation policies.

3AC.1

Investigating Effects of Biomass Burning Cross Plume Gradients and Plume Concentration on Photochemistry, Secondary Aerosol Formation, and Coagulation. NICOLE JUNE, Archana Dayalu, Marikate Mountain, Matthew Alvarado, Jeffrey R. Pierce, *Colorado State University*

The evolution of organic aerosols, aerosol size distributions, and ozone within smoke plumes are uncertain due to the variability across different smoke plumes and potentially in different locations of a single plume. We use the SAM-ASP large eddy simulation coupled with the TUV radiation model to examine evolution of ozone, organic aerosols, and size distributions within smoke plumes during the first several hours of aging. We configure the model to run for a case study on a fire sampled during the FIREX-AQ field campaign. We find that the model is able to reasonably capture the evolution of this smoke plume, representing evolution in both the transect averages and along in-plume gradients. We then run additional simulations to examine the impacts of variability in smoke concentrations on the plume evolution both in terms of a transect average and in plume gradients. We find evidence of faster photochemistry along the plume edges than in the plume core. Ozone formation is initially suppressed in-plume prior to the first transect of measurements, and increases in ozone start on the plume top and plume edges. Due to faster coagulation, the particle diameter grows faster in the center of the plume than on the edge. However, mixing between the edge and core allows for faster growth of particles in the edge than if there was no mixing. We find faster growth in plumes with a higher smoke concentration, and faster photochemistry in plumes of a lower smoke concentration. Our results may be beneficial to understanding how these processes may need to be parameterized in coarse-grid regional and global models.

3AC.2

Composition and Atmospheric Transformations of Organic Aerosol Emitted From Biomass and Urban Material Burning. KATHERINE HOPSTOCK, Alexandra Klodt, Michael Alvarado, Qiaorong Xie, Hind Al-Abadleh, Alexander Laskin, Sergey Nizkorodov, *University of California, Irvine*

Large-scale forest fires significantly contribute to the atmospheric influx of primary organic aerosol (POA) and volatile organic compounds (VOCs). These emissions undergo atmospheric processing to form secondary organic aerosol (SOA). Many studies have investigated the chemical composition of POA, generated through the combustion of various classes/species of biomass. In addition, studies have been conducted on how atmospheric processing of POA impacts its chemical composition and light-absorption properties. Globally, there is an increased frequency of devastating wildfire events that occur at the wildland-urban interface, burning not only biomass materials but also a wide range of ‘urban’ man-made materials. The chemical composition of VOC emissions from fires occurring at the wildland-urban interface is poorly characterized, as are their aged products.

This work compares the chemical composition of laboratory-generated proxies of POA from the pyrolysis and combustion of traditional biomass versus that of common urban materials. Chemical aging by 1) aqueous-phase reactions of transition metals, and 2) solar UV irradiation is explored by a suite of methods. UV-Vis spectroscopy is used to observe the optical properties of fresh and aged POA. Molecular characterization of fresh and aged samples is determined using ultra-high pressure liquid chromatography photodiode array high resolution mass spectrometry (UHPLC-PDA-HRMS) and temperature programmed desorption direct analysis in real time high resolution mass spectrometry (TPD-DART-HRMS). Two complementary ionization techniques, atmospheric pressure photo ionization (APPI) and electrospray ionization (ESI), are utilized to obtain broad coverage of both polar and nonpolar OA components. This work provides important input for source apportionment of POA from wildland-urban interface fires; chemical transformations that occur with aging POA; and understanding the composition of light-absorbing components in OA (i.e., brown carbon) from various combustion sources.

3AC.3

New Insights into the Detection and Chemistry of Levoglucosan in Biomass Burning Aerosol - Heterogeneous Chemistry and Novel Detection Methods. RAN ZHAO, Dylan Long, Max Loebel Roson, *University of Alberta*

As climate change proceeds, wildfires are expected to gain in both frequency and intensity. Understanding the impact of wildfire emissions on climate and air quality is a pressing research topic. The most commonly used molecular tracer of biomass burning is levoglucosan (LG), an anhydrosugar arising from the pyrolysis of cellulose. LG was considered chemically stable for a long time, but research from the past 15 years has revealed chemical reactions that can occur to LG in the atmosphere. Currently, a common detection method of LG involves chemical derivatization, followed by gas-chromatography-mass spectrometry (GC-MS), which can be costly and time-consuming. Identification of unrecognized reactions LG, as well as the development of novel techniques for its detection, will continue to be beneficial for research related to biomass burning. My research group has conducted a series of experiments to better understand the emission factors and heterogeneous chemistry of LG. During the process, we also recognized the importance of establishing both advanced and low-cost measurement methods for LG. This presentation will highlight our recent discovery that particle-phase levoglucosan can undergo heterogeneous reactions with atmospherically relevant electrophiles, such as acid anhydrides. Consequently, acid anhydrides undergo reactive uptake to biomass burning materials, forming larger organic acids that can contribute to secondary organic aerosol. Further, we developed novel techniques for the detection of LG, including two-dimensional GC-MS and an innovative and low-cost method, which employs commercial blood sugar glucometer strips.

3AC.4

Photoaging of Phenolic Secondary Organic Aerosol in the Aqueous Phase: Evolution of Chemical and Optical Properties and Effects of Oxidants. WENQING JIANG, Christopher Niedek, Cort Anastasio, Qi Zhang, *University of California, Davis*

While gas-phase reactions are well established to have significant impacts on atmospheric secondary organic aerosol (SOA) formation, the aqueous-phase aging of SOA remains poorly understood. This study investigates the evolution of the aqueous SOA (aqSOA) from guaiacyl acetone (GA), a semivolatile phenolic carbonyl commonly found in biomass burning smoke. The aqSOA was produced from GA reactions with hydroxyl radical (•OH-aqSOA) or a triplet excited state of organic carbon (^{3}C*-aqSOA) and then photoaged in water under simulated sunlight. High resolution aerosol mass spectrometry (HR-AMS) and UV-vis spectroscopy were utilized to track changes in composition and light absorption of the aqSOA during formation and aging.

Compared to •OH-aqSOA, the ^{3}C*-aqSOA is produced more rapidly and shows less oxidation, a greater abundance of oligomers, and higher light absorption. Prolonged photoaging promotes fragmentation and the formation of more volatile and less light-absorbing products. More than half of the initial aqSOA mass is lost and substantial photobleaching occurs after 10.5 hours of prolonged aging for ^{3}C*-aqSOA and 48 hours for •OH-aqSOA. Positive matrix factorization (PMF) analysis of the combined HR-AMS and UV-vis spectral data resolved three generations of aqSOA with distinctly different chemical and optical properties. The first-generation aqSOA shows significant oligomer formation and enhanced light absorption at 340-400 nm. The second-generation aqSOA is enriched in functionalized species, while the third-generation contains more fragmented products and is the least light-absorbing. Although photoaging generally increases the oxidation of aqSOA, a slightly decreased O/C of the •OH-aqSOA is observed after 48 hours of photoaging, likely due to greater fragmentation and evaporation of highly oxidized compounds. Increased oxidant concentration accelerates the transformation of aqSOA and promotes the decay of brown carbon (BrC) chromophores, leading to faster mass reduction and photobleaching.

3AC.5

Source Apportionment and Phase Partitioning of Atmospheric Semi-Volatile Organic Compounds during the Alaskan Wintertime. KAROLINA CYSNEIROS DE CARVALHO, Ellis Robinson, Andrew Holen, Judy Wu, Vanessa Selimovic, Damien Ketcherside, William Simpson, Peter F. DeCarlo, Kerri Pratt, Lu Hu, Robert J. Yokelson, Brent Williams, *Washington University in St. Louis*

Air pollution sources and atmospheric chemical transformations in Arctic cities change dramatically from season-to-season. During the winter, extreme low temperatures combined with industrial processes and increases in heating, result in larger local particulate matter emissions. The cold temperatures in conjunction with reduced solar radiation are responsible for longer temperature inversions that trap pollutants in the lower atmosphere leading to poor outdoor air quality. According to previous studies, there is an accumulation of fine particle matter in the Arctic atmosphere during wintertime and early spring but the understanding of atmospheric chemical reactions of these pollutants is poor and so is the extent of human exposure. During the 2022 winter, the Alaskan Layered Pollution and Chemical Analysis (ALPACA) campaign was deployed in the city of Fairbanks with the goal of improving our understanding of how pollutants behave under these extreme wintertime conditions.

A Semi-Volatile Thermal Desorption Aerosol Gas chromatograph (SV-TAG), capable of identifying and quantifying speciated organic compounds in both gas and particle phases, was deployed along with complementary gas-phase (PTR-ToF-MS - Proton Transfer Reaction Time-of-Flight Mass Spectrometer) and particle-phase mass spectrometers (ATOFMS - Aerosol Time-of-Flight Mass Spectrometer and AMS - Aerosol Mass Spectrometer). Positive Matrix Factorization (PMF) was applied to the SV-TAG dataset to identify major emission sources. Preliminary results suggest that wood burning is the main source of residential heating when strong temperature inversions prevailed. Speciated phase partitioning of fresh and aged biomass burning markers will be analyzed to help recognize the complex chemical transformation processes that these compounds undergo in the atmosphere under sustained cold and dark conditions. The low temperatures demonstrated to strongly drive gas-to-particle phase partitioning and its impact will be evaluated against other parameters such as compound-specific vapor pressure and total organic aerosol mass.

3AC.6

Laboratory Studies of Photolysis Aging of Brown Carbon Aerosols. DIEGO CALDERON-ARRIETA, Ana Morales, Taylor Estock, Anusha P.S. Hettiyadura, Chunlin Li, Yinon Rudich, Alexander Laskin, *Purdue University*

Composition and optical properties of atmospheric brown carbon (BrC) aerosols constantly evolve as a combined result of direct photolysis and multi-phase chemical reactions. Diverse chemical compositions in BrC exhibit varying reaction kinetics against atmospheric transformations, leading to erratic results of BrC in their optics and associated climate effect. Direct photolysis commonly degrades chromophores relating to their molecular weight and phase state, and thus may decrease the corresponding mass absorption coefficient (MAC) values of BrC. However, the exact photolysis pathways in molecular levels are still unclear for most BrC, particularly the biomass pyrolysis BrC with wide-spanning MAC. To fill the gap, a series of BrC with varying absorption were collected from wood smoldering and underwent photolysis in the laboratory. We found that photolysis alters the distribution of BrC chromophores and modifies optical properties and gas-particle partitioning of airborne aerosol. Our study identifies specific groups of BrC chromophores that have varying degrees of susceptibility and resilience to photolysis aging. To examine these changes in chemical compositions, we employed a molecular characterization approach utilizing a hyphenated platform that combines high-performance liquid chromatography interfaced with a photodiode array detector and high-resolution mass spectrometer. Our data reveals BrC chromophores that are either photobleached or formed through photolysis-induced condensation reactions. Our presentation will highlight molecular identities of the BrC chromophores grouped by their optical properties and susceptibility to solar irradiation, as well as characteristic time scales for the photochemical aging. Our experiments provide insights into the photochemical stability of BrC and offer valuable information for atmospheric chemistry models.

3AP.1

Predicting Real Refractive Index of Organic Aerosols from Elemental Composition. YAOWEI LI, Bin Bai, John Dykema, Nara Shin, Andrew Lambe, Qi Chen, Mikinori Kuwata, Nga Lee Ng, Frank Keutsch, Pengfei Liu, *Harvard University*

Atmospheric aerosol particles have a significant impact on the Earth's climate by interacting with radiation and water. Despite their large contribution to sub-micrometer aerosol particle mass, our understanding of the optical properties of atmospheric organic aerosols (OA) is still limited. One of the challenges is that the refractive index, i.e., the intrinsic optical constant of OA material, is poorly constrained. The lack of knowledge on the refractive index of OA can cause large uncertainties in estimating their optical properties and radiative effects on climate.

Here we present a semiempirical model that predicts the real refractive index *n* of OA material from its widely measured oxygen-to-carbon (O:C) and hydrogen-to-carbon (H:C) elemental ratios. The model was developed based on the theoretical framework of Lorenz-Lorentz equation and trained with *n*-values measured at 589 nm (n_{589nm}) of 160 pure compounds. The predictions can be expanded to predict n-values in a wide spectrum between 300 and 1200 nm. The model was validated with newly measured and literature datasets of *n*-values for various laboratory secondary organic aerosol (SOA) materials. The uncertainties of n589nm predictions for all SOA samples are within ±5%. The model suggests that the n_{589nm} values of OA, consisting mainly of C, H, and O, may vary within a relatively small range for typical O:C and H:C values observed in the atmosphere. Our results support a simplified representation of using a constant *n* value for ambient OA consisting mainly of C, H, and O in large-scale Earth system models. However, our parameterization can be also readily implemented in process-based aerosol models with OA elemental ratios represented.

3AP.2

Enhanced Radiative Forcing Effects and Albedo Reduction from Brown Carbon Aerosol Deposition on Glacier Snow. GANESH CHELLUBOYINA, Benjamin Sumlin, Payton Beeler, Rajan K. Chakrabarty, *Washington University in St. Louis*

As wildfire frequency and intensity have trended upward in recent years, the deposition of light-absorbing aerosols of biomass-burning origin on snow and ice has gained salience. These impurities, when dispersed in snow and ice, induce a reduction in surface albedo compared to pristine snow. Previous studies have extensively measured the concentrations of black carbon (BC) and mineral dust in snow, and attributed albedo reductions to these constituents. However, the influence of brown carbon (BrC), which is co-emitted with BC in wildfires, on albedo remains poorly constrained, and has not been examined as much on account of the wide variability in its optical properties, as well as its differing solubilities.

BrC can be further categorized based on its optical properties, with strongly absorbing BrC (S-BrC, k550 in the range 0.1-0.25) approaching the spectral imaginary refractive index of BC. We simulate aerosol dispersal scenarios in glacier snow to calculate spectral and broadband albedo responses to varying BrC optical properties and concentrations. These optical properties are drawn from parameterizations and FIREX field campaign data. Our results show that, at 1 ppm of aerosol in snow, the strongest absorbing BrC can produce a broadband albedo reduction of up to 0.12 between the wavelengths 400-1000 nm. Within the category of S-BrC, for the same concentration of BrC aerosol, the spread in albedo reductions can be as large as 0.11. Further, we show the results of a combined sensitivity analysis that includes snow microphysical properties such as ice grain size along with aerosol optical properties, and develop a parameterization to predict broadband albedo.

To validate these results, we compare the simulated spectral albedos with real-world measurements from mountain slope sites available in the literature. We also calculate the annual-mean radiative forcing for select locations, and an energy balance analysis is performed. These results may be of interest in better predicting glacier and snow melt in areas downwind of forest fires.

3AP.3

Direct Influence of Aerosol Particles in Cavity Enhanced Spectroscopy. FELIX STOLLBERGER, Michael Gleichweit, Ruth Signorell, Alexander Bergmann, *Graz University of Technology*

Cavity-enhanced spectroscopic techniques provide superior sensitivity compared with cavity-free methods. Consequently, they are well suited for the in-situ study of aerosol microphysics and for identifying the environmental impact of aerosols, which still needs to be quantified with the desired accuracy. Among those techniques are cavity-ring-down spectroscopy, cavity-enhanced Raman spectroscopy, and photothermal interferometry to probe particle extinction, chemical information, absorption, and physicochemical properties.

Introducing an aerosol particle into a cavity directly affects the optical properties of a cavity in terms of a position dependent extinction and phase contribution. The phase contribution is based on interference of coherently forward scattered light. Both must be considered if the reflectivity or transmissivity of the cavity is monitored for sensing purposes. We present a theoretical model for this cavity-particle interaction based on a Fabry-Pérot etalon, considering cavity geometry, particle size, refractive index, and particle position within the intra-cavity standing wave. We validate our theoretical findings with measurements of single, optically trapped aerosol particles inside a Fabry-Pérot etalon (FPE). Excellent agreement between the model and experiment was achieved. Based on our model, we were able to show that the effect of extinction exceeds the phase contribution due to coherent forward scattering by nearly two orders of magnitude in the observed size range of 600 nm to 3.2µm. However, small changes in the etalon geometry significantly influence the ratio of the two effects. Minor variations in the etalon collection angle and beam diameter increased the phase contribution by a factor of 64.

Overall, we could successfully model the influence of a single micrometer-sized particle on the reflectivity of an FPE and provide the first direct observation of this effect by measurements. Our findings will increase the accuracy of cavity-enhanced methods by accounting for the bias created by the presence of the aerosol particle. Furthermore, the method can be used as a novel analysis method for retrieving complex scattering information from isolated particles.

3AP.4

Optically Trapped, Single-Particle Reactor for the Study of Heterogeneous Chemistry. YUKAI AI, Chuji Wang, Gorden Videen, Yong-Le Pan, *Mississippi State University*

Mercury is a neurotoxin that impacts human health and the health of ecosystems globally. Mercury exists in the atmosphere in three major forms: elemental mercury, gaseous oxidized mercury, and particulate-bound mercury. To date, gaseous-phase mercury chemistry has been extensively studied. However, mercury's heterogeneous and surface chemistry, which is mostly related to the particulate bond mercury, and is associated with chemical reactions at atmospherically relevant surfaces, such as aerosols, air-water interfaces, etc., has been much less investigated. This is mainly due to the experimental difficulties in making accurate measurements, for example, due to the wall effect and surface interferences.

In this study, we created a micron-sized, single-particle reactor (SPR) freely trapped in air using optical trapping of a single particulate-bound mercury particle that was formed by mixing Hg(II) halides (HgX_2, X_2=Cl_2, Br_2 or BrCl) with single-walled carbon nanotubes (SWCNT). We observed chemical reactions on the surface of SPRs (HgX_2 contained single SWCNT particles) in the O_3 environment under the radiation of 532-nm light, based on Raman spectra changes. We propose a reaction mechanism: $Hg(II)X_2$ (solid) + O → Hg(I)X + XO, XO + O → O_2 + X on the surface of the SPR. This SPR technique may serve as a new reaction platform for the study of surface and heterogeneous chemistry in the simulated atmospheric state.

3AP.5

Non-contact Surface Sampling: Aerodynamic Resuspension of Particulates by Planar Impinging Jet. Byron Ockerman, Kalyan Kottapalli, Guanyu Song, Patrick Fillingham, IGOR NOVOSSELOV, *University of Washington*

Residues of hazardous substances, such as chemical compounds with low vapor pressure, radioactive particles, and biological contamination, can remain on surfaces for a prolonged time. The fate of these particles partially depends on the aerodynamic resuspension rates from the surfaces. These rates are a function of particle and surface properties and environmental conditions. Aerodynamic resuspension can be used for non-contact surface sampling. The effectiveness and sampling throughput of trace residues detection can be significantly enhanced by integrating an analytical instrument with a properly-designed sampling system. We present the analysis of the removal rates of Trimethylenetrinitramine (RDX) using an impinging flat jet as a function of the wall shear stress [1, 2]. The effect of the jet duration is studied experimentally; the removal efficiency increases slightly for greater exposure times, with most particles removed in the first 10 ms of exposure [3]. The optical analysis is compared with the chemical extraction method and analyzed by the LC-MS. The microscopic approach had errors in the 3-46% range compared with LC-MS analysis. Aerodynamic removal efficiency from Nylon was quantified using LC-MS, and the same flow conditions yielded greater removal efficiency from fibrous substrates compared to smooth substrates. The LC-MS method for RDX removal analysis has shown good repeatability and was effectively used for trace particle resuspension analysis from fibrous substrates, where the optical method had significant limitations.

The non-contact surface sampler was developed utilizing opposing planar jets geometry that enables aerodynamic trapping of particles. Angled jets direct a large fraction of the flow toward the center of the sampling area, resulting in an upward flow toward the sampler inlet. The aerodynamic trapping was observed experimentally via high-speed videography coupled with Schlieren imaging and numerically by computational fluid dynamics (CFD) [4]. The flow is aspirated through the reusable collection media to ensure the most efficient capture of particles.

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3AP.6

Understanding the Impact of Particle Morphology on Resuspension with a 3D Printed Wind Tunnel. EDWARD NEAL, Jonathan P. Reid, Richard J. Thomas, Maurice Walker, Jack Vincent, Simon Parker, Virginia Foot, Benjamin Higgins, *University of Bristol*

Particle resuspension is omnipresent in our lives with activities such as cleaning, walking, and driving, all contributing to resuspended aerosol concentrations. Existing mechanistic models for resuspension, however, have limited complexity due to a lack of understanding on contributing factors and are neglected in aerosol dispersion models. This project aims to show that a low cost, small-scale, 3D printed wind tunnel offers an accessible route to filling this gap in experimental resuspension research.

The wind tunnel has been tailored to a laboratory setting with an open design that measures below one meter in length and a largest cross section of 256 cm2. It has been constructed to reflect the commonly studied resuspension scenario of a particle residing in the sub-viscous boundary layer of a fully developed turbulent flow. Dry compressed air enters the tunnel via a mass flow controller and is conditioned within a settling chamber before turbulence is induced and allowed to develop. Particle removal downstream is captured by a camera operating at 200-500 FPS. This high temporal resolution and data acquisition rate provides rarely recorded particle resuspension velocities and an insight into collision events that lead to multiple particles resuspending.

Within this research the potential limitations of using a 3D-printed approach are analysed with investigations into the effects of static and tunnel surface roughness on the resuspension of glass standards. This, alongside verification of the expected turbulent flow, provides validation of the ideal removal scenario and a foundation for introducing complexity to resuspension models.

Particles with varying, yet reproducible, morphologies can be manufactured with unique instruments at the University of Bristol where droplets are dried under controlled relative humidity conditions. When resuspended these particles will provide insight into how morphology impacts particle detachment and demonstrate the table-top wind tunnel as a method for rapid and accessible resuspension experiments.

3HA.1

Effects of Atmospheric Aging on the Dithiothreitol-based Oxidative Potential of Carbonaceous Aerosols. KA YUEN CHEUNG, Jun Zhang, Tiantian Wang, Lisa Kattner, Sophie Bogler, Martin Gysel, Jay G. Slowik, Vishal Verma, André S. H. Prévôt, Imad El Haddad, David Bell, Robin Modini, *Paul Scherrer Institute*

Carbonaceous aerosols are directly emitted into the atmosphere from a variety of sources (e.g. combustion processes) or formed from the atmospheric oxidation of biogenic or anthropogenic precursors, which account for a large fraction of particulate matter (PM) in the ambient. Atmospheric aging processes continue to alter the chemical and physical properties of carbonaceous aerosols, so does the oxidative potential (OP) which is a measure of their ability to generate reactive oxygen species (ROS). Understanding how aging processes affect the OP of different types of carbonaceous aerosols is therefore crucial for predicting their potential health effects in different regions and under different atmospheric conditions. Numerous smog chamber studies investigated the OP of carbonaceous aerosols from various sources or aging processes. However, large uncertainty remains and inconsistent results may be due to the lack of standardized protocol for OP measurement, which hindered the direct comparisons among studies.

In this study, we conducted smog chamber experiments to investigate the OP as a function of aging for carbonaceous aerosols from two complex emissions (i.e. residential wood burning and coal combustion) and two single-precursor systems (α-pinene-derived and naphthalene-derived secondary organic aerosols (SOA)). In particular, we broadly explore the changes in OP of carbonaceous aerosols from residential wood burning under a range of atmospheric aging processes including OH photochemical reaction, ozonolysis in the dark, and NO_3 nighttime oxidation. We measured the hourly OP with a semi-continuous system for dithiothreitol (DTT) assay, together with measurements by aerosol mass spectrometer (AMS), scanning mobility particle sizer (SMPS) and gas analyzers. These provided transient information for more in-depth comparisons of aerosol toxicity in terms of the intrinsic OP (OP_m^{DTT}) among different types of carbonaceous aerosols at a given equivalent aging time. Our results show that OH photochemistry could produce aerosols with high OP_m^{DTT} more rapidly than other oxidation pathways.

3HA.2

Machine Learning Models to Predict Oxidative Potential of Ambient PM2.5: A Midwestern US Case Study. TAHSINA ALAM, Hannah Horowitz, Lei Zhao, Vishal Verma, *University of Illinois Urbana Champaign*

The study aims to use machine learning approach to develop predictive models for oxidative potential of ambient particulate matter ($PM_{2.5}$) from its chemical composition. Oxidative potential is an intrinsic property of the particulate matter which measures the ability of the particles to consume cellular antioxidants or generate reactive organic species (ROS) which can oxidize key cellular components. This oxidative potential has been found to be more strongly associated with the health effects of PM compared to routinely measured PM mass. In this research, we are generating the training datasets by measuring OP endpoints of different chemical mixtures containing varying concentrations of inorganic and organic aerosols found in $PM_{2.5}$ such as ammonium sulfate ($(NH_4)_2SO_4$), ammonium nitrate (NH_4NO_3), humic-like substances (HULIS), hydrocarbon-like and oxygenated organic aerosols (HOA and OOA) and metals [Cu(II), Mn(II) and Fe(II)]. The test concentrations of model species were chosen based on their typical ambient concentrations and conventional filter extraction protocols. The OP is being measured using two end points: dithiothreitol assay (OP_{DTT}) and consumption of reduced glutathione or GSH (OP_{GSH}). A total of 972 samples will be analyzed to measure all possible mixtures. Binary mixtures will be used to quantify any synergistic or antagonistic interaction between the components. The measurements were carried out using a Semi-Automated Multi-Endpoint ROS Activity Analyzer (SAMERA). The experimental data will be modeled using six different algorithms: Multi Linear Regression, Support Vector Machine, Artificial Neural Network, Random Forest, Gaussian Process and XGBoost. The models will be validated against OP measurements of ambient PM samples collected from different locations in the midwest USA. The sample and data analysis are currently underway. Suitable model will be selected based on coefficient of determination (R^2) and root mean square error (RMSE). Our final goal is to integrate the model with community earth science model (e.g. GEOS-Chem) for OP forecast across Midwestern US.

3HA.3

The Influence of Meteorological Conditions on Traffic-related SOA Formation and Its Relationship with OP.

LI-TI CHOU, Po-Kai Chang, Ta-Chih Hsiao, *National Taiwan University, Taiwan*

Oxidative potential (OP), defined as a measure of PM's capacity to oxidize target molecules through the generation of reactive oxygen species (ROS), has been commonly used to reflect the toxicity of particulate matter (PM) in recent studies. The formation of secondary organic aerosol (SOA) from radicals reacting with volatile organic compounds (VOCs) has raised significant concerns due to its effects on human health and climate change. In Southeast Asia, vehicle emissions containing abundant VOCs are one of the important sources leading to SOA formation in urban areas. Studies have shown that atmospheric processes can trigger PM's redox reactions and promote SOA formation, thereby influencing OP. However, most related studies have focused on conducting such research in the laboratory. This study uses a homemade oxidation flow reactor (OFR) to mimic the atmospheric environment. To accurately assess public exposure to traffic-related SOA, the OFR is set up in a near-road monitoring station, integrating several field instruments including the scanning mobility particle sizer (SMPS), aerodynamic particle sizer (APS), aethalometer, aerosol chemical speciation monitor (ACSM), etc. For the determination of OP, the DTT assay has been chosen solely because it is most relevant to health outcomes and responsive to several chemical species. Our aim is to investigate the impact of SOA formation from traffic emissions on OP under different meteorological conditions, such as temperature, relative humidity, solar irradiance, etc. Additionally, we will explore the detailed physical and chemical transformations of particles through atmospheric reactions simultaneously.

3HA.4

Accessing the Oxidative Potential of Dust from the Great Salt Lake.

REUBEN ATTAH, Kerry Kelly, Kevin Perry, *University of Utah*

Climate change and drought conditions have led to an increase in arid and semi-arid land globally. The Great Salt Lake, which lies west of Utah’s densely populated Wasatch front (80% of Utah’s population), has reached historic low levels with more than 1945 km2 of the exposed lakebed. This lakebed has a significant amount of minerals and elevated levels of arsenic, lead, and copper. Increasing dust levels and dust events are a concern along the Wasatch front because dust events transport high concentrations of harmful metals from the drying Great Salt Lakebed, leading to negative impacts on air quality and increased human exposure. Several studies have linked exposure to dust to mortality and morbidity caused by respiratory health effects. Some studies also suggested that the health effects of particulate matter (PM) can be linked to its oxidative potential (OP), which is a measure of the capacity of PM to generate reactive oxygen species (ROS), and ROS formation is a possible pathway linking PM exposure and adverse biological responses. Although several studies have examined the OP of urban PM sources such as combustion particles, however, OP measurements from natural sources such as dust are scarce, and no studies have evaluated the oxidative potential of dust from the GSL. This study aims to understand the OP of dust from the GSL. The investigators collected PM samples from 42 different locations along the GSL where the wind is likely to entrain dust. These samples were sieved to PM75 and then aerosolized and collected on a filter to obtain the respirable size fraction (PM10). The dithiothreitol (DTT) acellular assay was used to determine the OP of the PM10 samples from 42 sites. Multivariate analysis was used to relate OP results to chemical characteristics and location.

3HA.5

Aqueous OH Radical Production by Brake Wear Particles.
SUKRITI KAPUR, Ting Fang, Kasey Edwards, Véronique Perraud, Lisa Wingen, Adam Thomas, James Smith, Manabu Shiraiwa, *University of California, Irvine*

Non-tailpipe emissions, associated with brake and tire wear, are increasingly becoming important as we transition from internal combustion vehicles. Compared to tailpipe emissions that are well regulated, non-tailpipe emissions are less explored and are projected to be responsible for a major fraction of traffic-related PM. We generated brake wear particles (BWPs) with ceramic and semi-metallic brake pads using an in-house dynamometer. Particles were collected on Teflon filters and extracted in water prior to analysis. We measured Environmentally Persistent Free Radicals (EPFRs), which are long-lived radicals in the particle phase, and the production of Reactive Oxygen Species (ROS), including hydroxide (•OH), superoxide (O2•−), and hydrogen peroxide (H2O2), which play an important role in inducing oxidative stress. To understand cellular responses to BWPs, we quantified the superoxide release from macrophages upon exposure to BWPs using Diogenes chemiluminescence assay. We also determined the oxidative potential of the BWPs using the dithiothreitol (DTT) assay. Measurements showed that •OH was a dominant radical formed in water extracts, with a higher concentration measured in the semi-metallic BWPs compared to the ceramic BWPs. Ultrafine particles showed higher •OH per mass than the fine and coarse particles. However, EPFRs were not detected in any BWPs generated from the brake dynamometer system. DTT assay resulted in similar activity per mass (47 ± 16 pmol min^{-1} µg$^{-1)}$ for both types of brakes, indicating that both brakes have similar redox active species. These values are similar to previously reported values near highways in California (~37 pmol min^{-1} µg^{-1}). Furthermore, metal analysis using inductively coupled plasma mass spectrometry (ICP-MS) showed iron to be the highest contributor to both brake types. These findings serve as a basis for understanding health impacts of brake wear particles.

3HA.6

Are Health Effects of Ambient PM2.5 Proportional to its Mass? Relevance of Toxicity Measurements in Predicting PM2.5 Health Effects. SUDHEER SALANA, Zhuying Dai, Haoran Yu, P. S. Ganesh Subramanian, Vishal Verma, *University of Illinois at Urbana-Champaign*

Most epidemiological models use PM mass as a metric to predict health effects. However, there are several issues with such models. First, PM mass does not capture spatiotemporal variations in PM chemical composition. Second, the relationship between PM mass and its toxicity may also suffer from spatiotemporal heterogenity and hence the results of epidemiological models may not be extrapolated from one region to another. Therefore, alternative metrics are needed that can comprehensively represent PM health effects. In this study, we demonstrated the relevance of using PM toxicity measurements over PM mass using a large number of $PM_{2.5}$ samples (n>350) collected from fourteen different sites across four different continents (Asia, Europe, North and South America) and evaluating five PM toxicity surrogates [3 acellular oxidative-potential (OP) endpoints – OP_{DTT}, OP_{GSH}, $OP_{OH\text{-}SLF}$; 2 cellular endpoints cell-viability using Crystal-Violet assay and cellular-ROS using Dichlorofluorescein-diacetate (DCFH-DA) in a human-lung-epithelial cell-line (A549)]. Our results show that the variation in mass concentrations [Coefficient-of-Variation (CoV)~20-40%] within a site is much smaller than the variation in extrinsic toxicity measurements (CoV~40-100%) and the concentrations of different PM chemical species (CoV~25-100%). The relationship between mass and extrinsic toxicity varied spatially. Samples collected in UK and Chile showed a strong correlation (r>0.7) between mass and almost all the extrinsic toxicity endpoints. However, none of the extrinsic toxicity endpoints had a strong correlation (r<0.5) with PM mass in the samples collected from India and Midwest USA. Even the sites displaying high correlation between toxicity and mass, showed variable slope (toxicity vs. mass) indicating differential levels of intrinsic toxicity among these sites. For example, the average $PM_{2.5}$ mass concentrations were highest in India, but the intrinsic PM toxicity was lower than for most of the sites. Similarly, $PM_{2.5}$ mass concentrations in Midwest USA and Atlanta were much lower (~4-20 times) than those in Chile and India, but the intrinsic PM toxicities was comparatively high (~2 times). These results emphasize the need for alternative metrics of PM, to better represent PM induced health effects. OP could be one of such metrics, but more worldwide studies (such as the current one) are needed to understand its spatiotemporal distribution and confirm its health relevance based on epidemiological studies.

3IM.1

Detection of Bioaerosol by Measuring Single Particle Differential Circular Polarization Scattering (CIDS).

YONG-LE PAN, Aimable Kalume, Chuji Wang, Joshua L. Santarpia, *U.S. Army Research Laboratory*

Rapid detection and characterization of bioaerosol has been an important research topic for health and environment sciences. Currently real-time bioaerosol detection is mainly based on fluorescence, elastic scattering etc. optical methods, their effectiveness are often limited by the prevalence of interferents and significant costs. These inadequacies led to new exploration.

It was reported that DNA helical structures in biological molecules produce non-zero circular intensity differential scattering (CIDS, normalized Mueller scattering-matrix element S14/S11) as compared to other particles with non-helical structures. To date CIDS measurements have only been carried out for a group of particles using a polarization modulator, lock-in amplifier, and rotating detector due to its ultra-weak signals (10-3-10-6). Such complex instrumentation is not suitable outside a laboratory setting for use as a biosensor.

We report an advanced design, improved from our previous work (Optics Express 30 (2), 1442 (2022)), for measuring CIDS from single individual flowing through particles without any moving parts or modulator. An elliptical reflector is used to project scattering light at different angles onto a 32-anode PMT for phase function recording with two illuminating laser beams in left- and right-circular polarizations, which are 80 mm separation around the focus of the reflector as a particle moving through them with 8 ms time interval. This innovative setup, significantly, shortens a complete measurement from tens of minutes to 17 ms. CIDS phase functions from single particles of B. subtilis, E. coli spores, MS2 bacteriophage, Yersinia rohdei, DNA-tagged polystyrene (PSL) microsphere, tryptophan, PSL microsphere, atmospheric aerosol particles are carried out using this system. The results showed all bioaerosol particles have at least 3 times stronger CIDS signals than non-bioaerosol particles. This newly developed system gives promise to a rapid bioaerosol monitoring system with low cost and reduced risk for potential interferents.

3IM.2

A Computational Sensitivity Study To Refine Photoacoustic Absorption Signals Through Geometry Optimization.

PRABHAV UPADHYAY, Benjamin Sumlin, Rajan K. Chakrabarty, *Washington University in Saint Louis*

Aerosols can absorb and scatter solar radiation, leading to changes in the radiative balance of the atmosphere and impacts on climate and air quality. Specifically, the absorption of sunlight by aerosols can lead to atmospheric warming. Measuring aerosol light absorption is essential to understand these effects, and photoacoustic spectroscopy (PAS) is a widely used technique for this purpose. However, the sensitivity of PAS measurements is limited by several factors, including background noise, electrical interference, and other sources.

Improving the signal-to-noise ratio of PAS measurements is an important goal for accurate and precise measurements of aerosol light absorption. This limitation can be addressed by increasing incident laser power or optimizing the cell geometry. Higher laser power beyond a certain point can lead to vaporization of volatile compounds. Rather, we seek to optimize the geometry by increasing the quality factor (Q_c) of the photoacoustic cell and optimizing the transfer function of the acoustic notches, or Helmholtz resonators, which define the acoustic boundary conditions. Q_c is affected by various factors like loss of energy by fluid viscosity, heat conduction through the instrument walls, and the laser modulation frequency relative to that of cell resonance.

We propose a computational fluid dynamics model to simulate the PAS instrument and carry out a sensitivity study on the geometry of the Helmholtz resonators and the photoacoustic cell. The modeling is done in COMSOL Multiphysics and includes the acoustics module. This model involves solving the photoacoustic wave equation in the frequency domain and simulating the behavior of a PAS system under different conditions to identify the optimal design parameters for maximizing the signal-to-noise ratio and reducing measurement uncertainties.

3IM.3

Real-Time Measurements of Respirable Crystalline Silica, Kaolinite, Coal, and Calcite Dust with a Quantum Cascade Laser Equipped Photoacoustic Instrument.

W. PATRICK ARNOTT, Charles Kocsis, Xiaoliang Wang, Bankole Osho, Samuel Taylor, Pedro Nascimento, Bjoern Bingham, Chauntelle Murphy, Michael Sandink, *University of Nevada, Reno*

Practical, real-time measurements of speciated dust mass concentration (SDMC) are needed for health and ventilation applications in industrial applications such as mining. The most common method requires deposition of dust on filters through use of a vacuum pump, and subsequent Fourier Transform Infrared Spectroscopic analysis. We are developing a photoacoustic spectrometer (PAS) equipped with a tunable quantum cascade laser (QCL) to measure SDMC in real-time. In laboratory experiments, the QCL has been sequentially tuned to four wavelengths to quantify the SDMC of respirable crystalline silica (RCS), kaolinite, coal, and calcite. Each dust type also absorbs a little laser light at the other three wavelengths. A matrix of measurements quantifies the relationship between SDMC and aerosol light absorption at the four wavelengths. The inverse of this matrix provides SDMC from PAS measurements for a mixture containing all four dust types. Individual and mixed dust measurements demonstrate the current state of the art in PAS sampling of SDMC. Light absorption by water vapor can be used to calibrate the instrument. These measurements also have applications in the atmosphere to infrared radiative forcing by dust.

3IM.4

Comparison of Optical Properties Calculated from a Dual-Spot Aethalometer and a Photoacoustic Spectrometer for Biomass Burning Aerosols during the GWISE Campaign.

RYAN POLAND, Zachary McQueen, Omar El Hajj, Chase Glenn, Anita Anosike, Kruthika Kumar, Joseph O'Brien, Rawad Saleh, Geoffrey Smith, *University of Georgia*

The Georgia Wildfire Simulation Experiment (GWISE) was designed to study the chemical and optical properties of particulates resulting from wild and prescribed fire smoke, which often contains large portions of highly absorbing “black carbon” (BC) and “brown carbon” (BrC). The controlled nature of these simulated wildfires allows for comparison of the optical properties of biomass burning aerosols measured by the commercially available seven-wavelength dual-spot AE33 aethalometer (Aerosol Magee Scientific) and a custom, four-wavelength photoacoustic spectrometer (MultiPAS-IV) (Fischer and Smith 2018). Under both wild and prescribed fire conditions, we show that the AE33 over-estimates absorption by a factor of ~ 2 at all wavelengths. We also find that over-estimation of absorbance at 370 nm and 470 nm increases with increasing filter attenuation (ATN) above ATN values of 60. This observation suggests that the dual-spot loading compensation algorithm (Drinovec et al., 2015) is not able to account for loading effects quantitatively when aerosol optical properties change significantly at high filter attenuation values. Consequently, we recommend using the dual-spot aethalometer with an attenuation threshold for filter spot advancement of ATN = 60, reduced from the default value of 120. We also find that the absorption Ångström exponent (ÅAE), a measure of the shape of the absorption spectrum, calculated from the AE33 data agrees well (within 7%) with values calculated from the MultiPAS-IV data. However, ÅAE’s calculated in the ultraviolet/blue (dominated by BrC) and red/near-infrared (dominated by BC) regions from the AE33 data are 23 and 32% high respectively, when compared to those calculated from the MultiPAS-IV data. The systematic errors observed for these ÅAEs could lead to over-prediction of biomass burning percentage commonly used for source apportionment (Sandradewi et al. 2008).

3IM.5

Boundary Layer Profiles of Particle Turbulent Mass Fluxes at the Southern Great Plains Site. AJMAL RASHEEDA SATHEESH, Markus Petters, Nicholas Meskhidze, *NC State University*

Integrated measurements of aerosol, radiation, cloud, and turbulent transport in the planetary boundary layer are often viewed as essential for understanding and modeling climate and air quality. This study presents the results of a field campaign conducted at the DOE Atmospheric Radiation Measurement Southern Great Plains site in Lamont, Oklahoma in 2020. We use the data collected from two coherent Doppler lidars operating in vertically pointing and full upper-hemispheric scanning modes, the University of Wisconsin High Spectral Resolution Lidar (UW-HSRL) for inferring aerosol vertical turbulent mass fluxes at different altitudes within the boundary layer, and aerodynamic particle sizer, which measures the aerodynamic particle size distribution between ~0.5 µm and 20.0 µm. We present a new algorithm for the identification of convective turbulent regions within the boundary layer and characterize both diurnal variabilities (detected at 105 m, the lowest acceptable range gate of the Doppler lidar) and vertical profiles (retrieved four times a day) of aerosol mass fluxes. Our data analysis shows that at the site, the aerosol mass fluxes were in a range of -0.5 and 0.5 µg m-2 s-1 in the surface layer during mid-day, with upward fluxes occurring more often than downward fluxes. In addition to estimates of the aerosol mass flux, aerosol depolarization ratio, and backscatter color ratio (i.e., the ratio of aerosol backscatter coefficients at 1064 and 532 nm) reported by the UW-HSRL are used for inferring aerosol-intensive properties such as shape and size.

3IM.6

More Information from an Optical Particle Counter. DANIEL MURPHY, *NOAA CSL*

Optical particle counters are a basic instrument for aerosol research. I will present a new design for an optical particle counter that combines aerodynamic and optical sizing, but with extremely simple optics: one prism, one lens, one mirror, and one detector. A polarizing prism is the most novel element. The result is an optical counter with much more precision than a scattering-only optical particle counter and better calibration stability. The design can retrieve not only a size distribution but also information about the density and sphericity of the particles. The design can be optimized for various particle size ranges such as 0.1 to 2 µm or 0.5 to 5 µm.

The new design also incorporates a simple mirror geometry that largely eliminates the classic problem of non-monotonic scattering of laser light for particles with radii similar to the laser wavelength.

3SS.1

From Concentrations to Context: Approaches for Translating Sensor Network Data into Meaningful Outputs. NAOMI ZIMMERMAN, *University of British Columbia*

Increasingly, lower-cost air pollution sensors are being used by academics, government agencies and community organizations to understand local patterns of air quality and the impacts of sources such as traffic and wildfires. However, there is a disconnect between reported concentrations and being able to address/answer questions of interest to users, which include understanding spatiotemporal patterns, air pollution exposure, emission factors, and indoor-outdoor pollutant exchange.

In this talk, I will give an overview of different data treatment and modelling strategies to convert low-cost sensor network data into outputs that are more interpretable and actionable for user groups, with a focus on $PM_{2.5}$. This will include an introduction to data treatment methods such as isolating short-lived pollution events from persistent pollution enhancements and integrating wind data into the analysis, and then go on to discuss examples at different spatial scales: (1) building scale for indoor-outdoor exchange, (2) near-road scale for emission factors, (3) neighborhood scale for community advocacy, and (4) city scale for land use regression and exposure estimation. This will draw upon case studies from across Pittsburgh, PA, Vancouver, BC and Uttar Pradesh, India. Lastly, I will briefly touch on strategies for knowledge dissemination of maps or models built with sensor network data, since these networks are used by disparate groups who may benefit from knowledge sharing that goes beyond traditional academic approaches.

3SS.2

Data Fusion with Uncertainty Quantification for Sub-City-Scale Assessments and Forecasting of PM2.5 and Trace Gases. NATHAN PAVLOVIC, Carl Malings, K. Emma Knowland, Christoph Keller, Stephen Cohn, Callum Wayman, Alan Chan, Sean Wihera, Sean Khan, John White, Daniel Westervelt, Randall Martin, *Sonoma Technology, Inc.*

Sub-city-scale air quality estimates and forecasts are a critical need for areas that are disproportionately impacted by poor air quality or intermittent air quality events such as wildfires. Many information sources can support air quality assessments and forecasting, including atmospheric chemistry model outputs, satellite retrievals of column aerosols and gases, and surface-based air quality monitoring data from both regulatory and low-cost instruments. These sources of data span a broad range of spatial and temporal scales with respect to resolution and coverage. Our team is developing a data fusion approach with data from low-cost sensors, reference-grade monitors, models (CAMS, GEOS-CF), and satellites to develop near-real-time (NRT) forecasting of $PM_{2.5}$ and gases (NO_2 and O_3). The NRT forecasting will generate an hourly forecast of sub-city-scale (e.g., 1 km resolution) air quality estimates that will support decision-making needs for end users. Furthermore, the data fusion framework includes quantification of uncertainties in the resulting fused estimates based on the variability of each input data source and among the data sources. These capabilities will allow air quality managers to better understand their local air quality situations, including relative confidence in the fused estimates for different atmospheric constituents, locations, and times, leading to better informed air quality management decisions. This presentation (1) covers the underlying methodology of the data fusion and uncertainty quantification approaches, with a focus on the $PM_{2.5}$ component; (2) provides an update on the status of its implementation; and, (3) presents early qualitative and quantitative results and case studies focused on aerosol events, such as wildland fire smoke and dust storms.

3SS.3

Trends of Present-Day On-Road Motor Vehicle Particulate Matter Emissions to Total PM Using a Low-Cost Sensor Network in Baltimore City. COLBY BUEHLER, Misti Zamora, Daniela Flores, Marley Macarewich, Lei Hao, Abhi Datta, Kirsten Koehler, Drew Gentner, *Yale University*

Historically, urban particulate matter concentrations ($PM_{2.5}$) have been driven by combustion-related sources, including mobile sources. In recent decades, emissions from motor vehicles have decreased substantially due to a number of factors, including improvements in emissions control technology, fuel composition, and the retirement of older high-emitting vehicles. This decrease in emissions inherently leads to larger relative contributions from other local urban sources (e.g., restaurants) or from transported pollution, which can differ spatially and over time. These changes have implications for human exposure to pollutants and associated health impacts.

Here, we evaluate the relative role of near-roadway $PM_{2.5}$ emissions (and other combustion-related pollutants) on concentration enhancements using high spatiotemporal data from the Solutions for Energy, AiR, Climate, and Health (SEARCH) low-cost air quality network (N=45) in Baltimore City, MD. Each monitoring site in the SEARCH network and nearby regulatory reference monitors are characterized using various land use metrics, traffic data, and roadway datasets. This is used to estimate the influence of different types of roadways (e.g., interstates, freeways, local roads, etc.) on spatiotemporal variations in concentrations over the course of multiple years. In the urban core of Baltimore City, annual average $PM_{2.5}$ concentrations have decreased from over 15 µg m^{-3} in the year 2000 to less than 10 µg m^{-3} in recent years while maintaining similar average annual daily traffic volumes. While overall long-term concentrations are low, significant site-to-site differences (e.g., >5 µg m^{-3}) relative to the network average were observed on time scales up to a month, with even greater differences observed at hourly time scales. Using a combination of meteorological data, reference monitoring stations, and SEARCH network sites that are upwind of the urban core, we estimate regional background $PM_{2.5}$ concentrations to determine $PM_{2.5}$ enhancements attributable to locally-emitted sources.

3SS.4

Spatiotemporal Distribution of Brown Carbon and Organic Aerosol Brownness Across the U.S. Chemical Speciation Network. L.-W. ANTONY CHEN, Judith Chow, Xiaoliang Wang, John Watson, Jingqiu Mao, *University of Nevada, Las Vegas*

The Chemical Speciation Network (CSN) consists of 145 sites in U.S. urban areas to track fine $PM_{2.5}$ chemical compositions. Carbonaceous aerosols, including organic carbon (OC) and elemental carbon (EC), are commonly quantified by CSN using different thermal/optical analysis (TOA) protocols and instrumentation since 2001. From 2016 to September 2018, carbon analysis followed the IMPROVE_A protocol using the DRI Model 2015 Multiwavelength Thermal/Optical Carbon Analyzer (Aerosol Corp., Berkeley, CA, USA) that quantifies OC, EC, and eight thermal fractions while simultaneously monitoring filter reflectance and transmittance at seven wavelengths (405–980 nm). These analyses offer an opportunity to measure black carbon (BC), brown carbon (BrC), and non-light-absorbing white carbon (WtC) based on the aerosol light absorption properties. Multiwavelength measurements yielded valid carbon apportionments for 38,134 samples. The resulting network averages for BC, BrC and WtC are 0.45, 0.39, and 1.60 µg m^{-3}, respectively, leading to an overall BrC/OC ratio (organic brownness) of 0.20. EC measured by the conventional TOA is 0.52 µg m^{-3}, and the overall r^2 between EC and BC is 0.76. Organic brownness varies strongly by season, ranging from 0.09 in summer to 0.35 in winter, despite similar OC levels of 2.23 and 2.03 µg m^{-3} in summer and winter, respectively. The seasonal contrast may reflect a higher fraction of weakly-absorbing secondary organic aerosol and/or more effective photobleaching during summer. Consequently, BrC light absorption at 405 nm achieved 13% and 36% of BC absorption in summer and winter, respectively. By site, BC averaged from 0.07 µg m^{-3} at Whiteface, NY to 1.21 µg m^{-3} at Charleston, WV, while organic brownness appeared to be inversely related to the BC/OC ratio. These findings can facilitate the incorporation of organic aerosol absorptivity into climate and visibility models.

3SS.5

Size-Resolved Characterization of Particle Hydroxymethanesulfonate (HMS), Sulfite, Bisulfite, and Sulfate in Wintertime Fairbanks, Alaska.

KAYANE DINGILIAN, Elliana Hebert, Michael Battaglia, James Campbell, Jingqiu Mao, Rodney J. Weber, *Georgia Institute of Technology*

Previous analysis of online and offline measurements of particulate matter during the ALPACA campaign of January-February 2022 in Fairbanks, Alaska identified significant levels of the S(IV) species hydroxymethanesulfonate (HMS), sulfite, and bisulfite, and the S(VI) species sulfate. Recent analysis of samples collected with a nine-stage Microorifice Uniform Deposit Impactor (MOUDI) show a strong dependence of the fraction of HMS in total S(IV) on particle size. HMS (organic S(IV)) dominates the fine mode (PM2.5) and sulfite and bisulfite (together termed “inorganic S(IV)”) dominate the coarse mode (PM >2.5). The total S(IV)/sulfate fraction also has a distinct trend, with the ratio above unity in the coarse mode and below half in the fine mode, possibly indicative of primary sources of inorganic S(IV). The data were categorized into three periods – the main pollution event (late Jan-early Feb), a contrasting clean period (mid Feb), and a period of intermediate total S(IV) levels (mid Jan). For all three periods, the total S(IV) distribution is bimodal, with a heightened relative contribution of HMS to total S(IV) in the fine mode during the intermediate and main pollution events. This suggests that HMS chemistry may not be the sole fate of aqueous inorganic S(IV) even in a formaldehyde-rich environment. We are investigating the possibility of additional physical and chemical factors enhancing or inhibiting HMS formation, such as particle liquid water content, diffusion and transport, precursor solubility and uptake, metal complexation, etc. Overall, size-resolved measurements of HMS, inorganic S(IV), and sulfate provide insights into the unique sulfur chemistry occurring in cold urban environments.

3SS.6

Correcting 20,000+ Low-Cost Sensors Without a Colocation: Development of a Global Gaussian Mixture Regression Model for Optical PM2.5 Sensors.

GARIMA RAHEJA, Daniel Westervelt, *Columbia University*

Air pollution is a leading cause of global premature mortality, and is linked to more than 1 million premature deaths in Africa per year. Advancements in low-cost sensors (LCS) are helping bridge the data gapa left by historically expensive and technically challenging reference-grade monitors. While novel data science techniques are being used to develop correction factors for LCS, these studies generally (1) use co-locations with expensive reference-grade monitors, (2) utilize temperature, humidity and other measurements to account for variation in hygroscopicity and optical properties, and (3) are often local in scope, limited to one city or metro area.

Can we use correction factors developed at one location, in another? We use co-locations from 25 cities (including Palisades, NY; Accra, Ghana; Lomé, Togo; Kinshasa, DRC; Kolkata, India) at varying climatologies and distances to assess the performance of a range of machine learning techniques (including Multiple Linear Regression, Random Forest, XGBoost and Gaussian Mixture Regression), and compare them to published correction factors in the literature. Additionally, we develop a Global Gaussian Mixture Regression (GMR) machine learning model trained on co-locations from cities in the Clean Air Monitoring and Solutions Network (CAMS-Net). GMR has proven successful for correcting LCS data: in Kinshasa, the GMR-corrected Purple Air data resulted in $R^2 = 0.88$ when compared to the MetOne BAM-1020, and in Accra, the GMR lowered the Mean Absolute Error of Clarity data from 7.51 $\mu g/m^3$ to 1.93 $\mu g/m^3$.

We find that in most cases, the Global Gaussian Mixture Regression model performs 57-96% as well as using a local correction model, which means it shows good promise for being useful in cases where no local colocation is available / feasible. In some cases, such as Nairobi, the Global Gaussian Mixture Regression model is actually 1.2x better than using a local model.

The wide breadth of the Global GMR allows for correction of LCS data without the need for a local co-location. We present an open-source dashboard that enables the correction of data from 20,000+ PurpleAir and Clarity sensors around the world without a reference monitor colocation.

3UA.1

Comparison of PM2.5 Measurements by Air Quality Monitoring Stations and Filter-based Method in Jakarta, Indonesia. ENDAH DAMASTUTI, Muhayatun Santoso, Desie Khoeratunnisya, Syukria Kurniawati, Djoko Prakoso Dwi Atmodjo, Faizal Ramadhani, Woro Yatu Niken Syahfitri, Feni Fernita Nurhaini, Philip K. Hopke, *National Innovation and Research Agency (BRIN), Indonesia*

Fine particulate matter, PM2.5, is considered to be the most significant ambient air pollutant in terms of potential health impacts. Indonesia is a vast archipelago with major cities scattered all over the island. It is very important for the government to be able to accurately assess the exposure of populations to PM2.5 across municipal areas. However, equity becomes the constraint in maintaining the sustainability of air quality management implementation across Indonesia. Several big cities in Indonesia have an Air Quality Monitoring Station (AQMS) to monitor air quality, including PM2.5, but only a few cities can maintain the operation of AQMS due to high costs. We conducted a comparative study of daily PM2.5 concentrations using a filter-based super SASS reference sampler and AQMS as an alternate method on air quality assessment. The study was conducted at two sites in Jakarta City; Central Jakarta (May 2022- January 2023) and North Jakarta (February-March 2023). The results showed that PM2.5 in Central Jakarta was 33.0 ± 15.4 µg/m3 by AQMS and 31.1 ± 15.4 µg/m3 by SASS, while in North Jakarta was 33.9 ± 12.6 µg/m3 by AQMS and 26.7 ± 12.6 µg/m3 by SASS. The results gave a good correlation with a coefficient of determination value (R2) of 0.94 and 0.95 for Central and North Jakarta respectively. It also found that ratio of AQMS to SASS PM2.5 concentration was shifted on PM2.5 concentrations higher than 40 µg/m3. The results of this study are expected as reference based on designing the air quality management plan for cities in Indonesia.

3UA.2

The Use of Black Carbon Sensors to Enhance Particulate Matter Monitoring in Communities. Rebecca A. Sugrue, CHELSEA V. PREBLE, James D.A. Butler, Alaia Redon-Gabel, Pietro Marconi, Karan Shetty, Lee Ann Hill, Audrey Smith, Boris Lukanov, Thomas W. Kirchstetter, *UC Berkeley*

Low-cost air pollution sensors are increasingly deployed to understand community exposures and determine local emission sources. Fine particulate matter ($PM_{2.5}$) is commonly measured, due in part to the affordability of commercial sensors. However, a significant portion of ambient $PM_{2.5}$ may be attributable to pollution sources beyond the community boundaries. This study measured concentrations of $PM_{2.5}$ and black carbon (BC), a component of $PM_{2.5}$ emitted primarily from diesel engines and biomass burning, using low-cost monitors that employed laser scattering and filter-based absorption photometry methods, respectively. Over four weeks in two seasons, a monitoring network with 50 locations in Richmond, California, was established to evaluate the information gained from measuring both pollutants. Concentrations of BC varied more than $PM_{2.5}$ both temporally and spatially. Monthly network-average BC was 3× higher in winter than late spring, while $PM_{2.5}$ was instead 10% lower. In both seasons, average $PM_{2.5}$ concentrations at two-thirds of sites were within ±10% of the network average, whereas only one-third of sites were within ±10% of the network-average BC concentration. The most and least polluted locations were more persistent across seasons for BC than $PM_{2.5}$, and there was little commonality in the sites that experienced the highest concentrations of BC and $PM_{2.5}$. While the five most polluted sites in the winter had an average BC concentration 2.2× the average concentration of the five least polluted sites, the temporal dynamics of the BC pollution at each of the sites were similar. Together, these spatiotemporal trends show that BC, a primary aerosol, is a better indicator for local pollution sources than $PM_{2.5}$.

3UA.3

Impacts of Precipitation on Aerosol Chemical Composition in a Highly Urbanized Area during the TRACER-MAP Field Campaign. CHUN-YING CHAO, Fangzhou Guo, Shan Zhou, James Flynn, Rebecca J. Sheesley, Sascha Usenko, Don Collins, Robert Griffin, *Rice University*

Wet deposition of pollutants is one process by which precipitation impacts air quality. For particulate matter, previous studies focused on changes in size distribution rather than chemical composition because of precipitation. To better understand how precipitation impacts aerosol composition, this study (1) investigates the in-situ chemical characteristics of aerosol before, during, and after precipitation and (2) compares the removal efficiencies of aerosol species for different rain events across a field campaign.

We measured aerosol composition using an Aerodyne high-resolution time-of-flight aerosol mass spectrometer during the Tracking Aerosol Convection Interactions - Mapping of Aerosol Processes (TRACER-MAP) field campaign in Houston, Texas, from July to September 2022. We made collocated precipitation intensity measurements using an AcuRite Multi-Weather Sensor. During July and August, we measured the aerosol composition and precipitation for periods of five to nine days at five different locations across Houston that represent a range of suburban/urban/industrialized locations. In September, we conducted measurements only at a single industrialized site.

Across the campaign, we observed 17 precipitation events that had a duration of 30 minutes or longer and had rain intensity ranging from 2.6 to 33.9 mm/hr. Changes in concentrations for individual species were both positive and negative in these events. However, relative and absolute changes in sulfate and organic aerosol were larger compared to those in ammonium, nitrate, and chloride. For sulfate, the largest mass concentration difference between before and during precipitation was from 2.90 to 0.81 $\mu g/m^3$ (a 58% decrease). For organic matter, the largest difference was from 6.67 to 1.99 $\mu g/m^3$ (a 70% decrease). These values indicate that sulfate and organic aerosol may have different wet removal mechanisms. The results will be used to estimate scavenging coefficients of individual aerosol species, which can improve modeling aerosol concentrations under different intensities of precipitation.

3UA.4

Aerosol Concentration, Size Distribution, and Cloud Condensation Nuclei Activity at 5 Sites in Houston during the TRACER-MAP Campaign. ZIHAN ZHU, Don Collins, Chun-Ying Chao, Robert Griffin, Kimberly Sauceda, Sascha Usenko, Rebecca J. Sheesley, Subin Yoon, James Flynn, *University of California, Riverside*

The Tracking Aerosol Convection Interactions Experiment - Mapping of Aerosol Processes (TRACER-MAP) was carried out in the summer of 2022 as part of the larger DOE TRACER campaign. The objective of TRACER-MAP was to characterize gas concentrations and aerosol concentrations and properties across the Houston Metropolitan area. This was accomplished through measurement of a range of aerosol, gas, and meteorological parameters at five different sites that were selected to encompass the diversity of atmospheric conditions and local and transported emissions throughout the urban and suburban area. The Baylor University/University of Houston Mobile Air Quality Laboratory-2 (MAQL2) was deployed at each site for 5-7 days to gather data on aerosol size distributions, cloud condensation nuclei (CCN) activity, aerosol optical properties, aerosol composition, trace gas concentrations, and meteorological parameters. The focus of this presentation is on the aerosol size distributions measured with a scanning mobility particle sizer (SMPS) and aerodynamic particle sizer (APS) and the CCN activity measured with a CCN counter operated downstream of the SMPS. The gathered data were analyzed to explore the impact of meteorological conditions on new particle formation (NPF) and growth, as well as to investigate the spatial variability of these phenomena. We observed high particle number concentrations and active NPF events at locations influenced by biogenic, industrial, and urban sources. The connection between convective rain events and particle formation, growth, and size distribution will be highlighted. The concentration of supermicron particles observed at our measurement sites was found to be correlated with that measured with another APS at the main TRACER site in La Porte, TX, which in part reflects the regional scale of large dust events. The average and diel profile of CCN activity varied amongst the sites.

3UA.5

Wind-Driven Emissions of Coarse Mode Particles in an Urban Environment. MARKUS PETTERS, Tyas Pujiastuti, Ajmal Rasheeda Satheesh, Sabin Kasparoglu, Bethany Sutherland, Nicholas Meskhidze, *North Carolina State University*

Emissions of coarse mode particles with a diameter greater than 0.5 µm provide giant cloud condensation nuclei and ice nuclei. Here we introduce a new method that uses lidar retrievals of the elastic backscatter and Doppler velocity to obtain surface number emissions of particles with diameters greater than 0.53 µm. Backscatter flux is calculated using the eddy-covariance technique. The attenuated backscatter is related to particle number concentration using an empirical calibration between attenuated backscatter stratified by relative humidity and particle number concentration above a certain size threshold measured by an optical particle counter at the surface. Number fluxes are then obtained from the backscatter flux through this calibration. The technique is applied to study particle number fluxes over a two month period during the TRACER campaign at an urban site near Houston, TX, USA. All of the observed fluxes were positive (upwards) indicating particle emission from the surface. The fluxes followed a diurnal pattern and peaked near noon local time. Flux intensity varied through the two months with multi-day periods of strong fluxes and multi-day periods of weak fluxes. Emission particle number fluxes peaked near ~100 $cm^{-2} s^{-1}$. The daily averaged emission fluxes correlated with friction velocity and were anticorrelated to surface relative humidity. The emission flux can be parameterized as $F = 3000u^{*4}$ where u* is the friction velocity in $m\ s^{-1}$ and the emission flux F is in $cm^{-2} s^{-1}$. The relationship of the flux with friction velocity is consistent with emission from wind-driven erosion. These results demonstrate that urban environments may play an important role in supplying coarse mode particles to the boundary layer.

3UA.6

PM2.5 Suppression of Ozone Formation at High Mass Loading. JAMES SCHWAB, Jie Zhang, Alexandra Catena, Janie Schwab, Matthew Ninneman, Junfeng Wang, Amanda Teora, *Atmospheric Sciences Research Center, University at Albany*

Recent work has highlighted the relationship between $PM_{2.5}$ and O_3 and the interplay of these two important pollutants in areas that suffer high pollution loading. Following the US National Ambient Air Quality Standards (NAAQS), we have analyzed summertime maximum daily 8-h average ozone (MDA8 O_3) in relation to the daily average $PM_{2.5}$ (DA24 $PM_{2.5}$). At low PM concentrations (below 20 or 25 $\mu g/m^3$), the two pollutants show a direct linear relationship. At higher PM concentrations the relationship curves and levels off - or even decreases. The flat or declining relationship has been partly attributed to the scavenging of HO_2 or NO_3 radicals, or to reduced photolysis rates due to the higher PM loading. We have fit a non-linear polynomial function to this full relationship and obtained a three term solution, with a linear term describing the $O_3/PM_{2.5}$ co-occurrence, a negative power function term reflecting the PM suppression of O_3 formation, and a constant term. We evaluate the PM suppression factor (the coefficient of the power function term) for a number of different locations in the Eastern US over the past 20 years. Detailed PM chemical composition measurements at NYC from four measurement periods over the study period allow us to interpret the reason for changes in the PM suppression factor. Inclusion of an additional eleven city sites in the Eastern US allows a more complete picture of the spatial and temporal variations and trends of the suppression factor. Finally, we examine the relationship between the PM suppression factor and the satellite measurements of the $HCHO/NO_2$ ratio (a frequently used indicator of the ozone production regime). The strong association between these two quantities leads us to conclude that the PM suppression factor can also be a useful measure of the ozone production regime.

4MJ.1

Gideon Maina, IoT Engineer/ Air Quality Monitoring Technologist, Industry/Government/Academia. GIDEON MAINA, *Code For Africa*

My current role is as Senior IoT Engineer for sensors.AFRICA is to oversee the development of low-cost air quality monitors; a befitting role that intersects my passion for clear air initiatives and my love for electronics and software development.

My experience has grown a specific interest in reliable and quality data on air pollution. The main challenge with currently available data especially on the African continent is that it is insufficient and reliable to give a clear picture of the air quality situation in the continent. One aspect that has been overlooked by researchers and policymakers is the technology used to collect these data which resulted in technologists being sidelined in this whole effort.

As an engineer by background, my problem-solving and analytical skills took effect. I have made a few proposals to various stakeholders in Africa such as harmonization of the data collection exercise, development of a standard in air quality data format, open framework for data access, and collaboration with experts to audit commercially available monitors as well as the data collection methodology used by institutions.

Additionally, I have developed an interest in air quality modeling using artificial intelligence. I am in the process of creating a playbook for air quality monitoring levering our open source initiative with existing frameworks and standards developed by other organizations. A role in Canada, the US or Europe will be beneficial to my efforts as these regions are comparably advanced in air quality monitoring.

4MJ.2

Ifechukwude Chiedu, Ph.D. Research Scientist/Quality Assurance Specialist, Academia/Government/Industry. IFECHUKWUDE CHIEDU, *Federal Institute of Industrial Research Lagos, Nigeria.*

As a Research Scientist at Federal Institute of Industrial Research Oshodi (FIIRO) Lagos Nigeria, my research experiences lie in the role of Analytical and Environmental Chemistry. It has encompassed many aspects of analytical techniques and environmental studies.

My research interest focuses on: elucidating the fate, behavior and effects of anthropogenic activities in soil, water and aerosol, elemental (heavy and light metals) characterization and source identification of fine particulate matter (PM2.5) in industrial and non-industrial areas, identification of organic and inorganic pollutants in air, water and soil with possible remediation, indoor and outdoor air quality, synthesizing and using Schiff base ligand as a chelating agent for the spectrophotometric determination of toxic metals in biological and environmental samples, method development and instrumental method of analysis using GC-MS, HPLC and AAS.

My extensive laboratory experience includes application of ISO 17025, using various testing methods and equipment to analyze chemical compounds. I have used instrumental methods like Gas Chromatography-Mass Spectrophotometer (GC-MS) for the analysis of compounds and also to detect and measure contaminants in biological and environmental samples. High Performance Liquid Chromatography (HPLC) in identifying and quantifying pesticides along with preservatives and artificial flavourings and colorants in food and environmental samples. I have also used an Atomic Absorption Spectrophotometer (AAS) to measure the concentration of elements in various samples and ensure the achievement of highly accurate results. My passion is based on investigating and setting standards for quality which involves health and safety and ensuring that biological and environmental samples comply with standards at both national and international level. I have proven experience in safely collecting of biological and environmental samples, preparing raw materials, handling samples for research, analyzing and presenting results. A role in the US, Canada, Europe is preferred. Availability is negotiable.

4MJ.3

Ryan W. Drover, Ph.D. Candidate at UC Riverside. RYAN W. DROVER, David R. Cocker III, *University of California, Riverside*

I am a 5th year Ph.D. candidate in the Department of Chemical & Environmental Engineering at the University of California, Riverside in Dr. David Cocker's group. My research spans a range of topics in sustainability, emissions, chemistry, and health, including contractual projects and policy-related work (UCR Science to Policy Certificate and active contributor to reports and events).

My work in emissions has centered on evaluating in-use modern ocean-going vessels (OGVs) with the most recent applications in control technologies and fuels (part of Zero- and Near Zero-Emission Freight Facilities with CARB and SC-AQMD). This has included working with the US EPA to develop an extensive database of in-use marine emissions (criteria pollutants, GHGs, air toxics) to develop a MOVES-equivalent model for OGV emissions. As part of this work, I work with vessel operation data, independently collected GIS data, and emissions data to evaluate vessel activity and address current issues with OGV emissions accounting and evaluation.

In the Atmospheric Processes Lab, I lead research in a global standard environmental chamber facility with studies on the atmospheric aging of wildfire smoke and the ozone formation potential of novel industrial chemicals. This work involves the use of extensive experimental instrumentation to evaluate physical and chemical properties, operated via LabVIEW, alongside the SAPRC atmospheric chemical mechanisms model.

Alongside biomedical and microbiology collaborators at UC Riverside, I work to develop models of immune and inflammatory response and disease development from aerosol exposures, with emphases on health disparities, the asthma crisis in the nearby Salton Sea region, and identifying air pollutant risks from other sources (wildfire smoke (fresh or aged), non-exhaust emissions, etc.).

My focus is translating primary- and secondary- research sources to apply scientific knowledge to critical environmental, pollution, energy, and health issues. This includes recent whitepapers on An Analysis of California's (Renewable Energy) Net Energy Metering Policy Proposals and Impacts, the Potential Health Impacts of a Distribution Center in [redacted California city], and Evaluating the Status of the Clean Technology Industry in the Inland Empire, Southern California.

I have extensive experience with programming languages (Python, R, MATLAB), quantitative & statistical methods, and pollution modeling (GEOS-CHEM, HYSPLIT, AERMOD, USGS PHAST, SAPRC, box models) through coursework, contractual testing projects, and research applications.

I am interested in opportunities in industry, government, national laboratories, or academic institutions. I do not have any geographical limitations.

Preferred start date: Spring/Summer/Fall 2024
Contact: rdrov002@ucr.edu

4MJ.4

Xinyang Guo, Ph.D. Candidate Pursuing Academia/Government/Industry Postdoctoral Positions. XINYANG GUO, *University of Alberta*

I am a fourth-year Ph.D. candidate in Dr. Ran Zhao's group at the University of Alberta, focusing on atmospheric chemistry, instrumentation, and chemical analysis. My thesis is to detect and quantify inhalable chemical compounds, as well as find out their implications for indoor air quality (IAQ) and occupational health.

My first project was published in the Indoor Air journal in 2022, the goal is to evaluate the impact on IAQ when using artificial fog. I established skills in using LC-MS instruments, as well as field sample collection and processing techniques in this project. At the same time, I was also serving as the mentor of an undergraduate researcher.

The manuscript of my second project has been submitted during the spring of this year, it is extended from the previous project and aimed to explore the autoxidation in glycol-based inhalable products. I mentored another undergraduate researcher and designed a concise experiment plan, which is targeting on detecting toxic carbonyls while glycol mixtures were aging in the indoor environment.

The third ongoing project is to quantify nitrogenous species in a commercial poultry farm. I was collaborating with one of my colleagues, who is working on different topics on the poultry farm. I designed and optimized sampling instruments that were made specifically for the poultry farm, due to the harsh environment. Additionally, I developed my own LC-MS method to quantify amines in aerosols.

Finally, I oversee instrumental maintenance and repair duties, as well as being the safety officer in the lab. My anticipated graduation will be by the end of 2024, I am looking forward to having a full-time post-doc position in the industry or a governmental organization in North America. If you have any further questions, please reach out to xtguo@ualberta.ca.

4MJ.5

New Insights Into the Composition of Organics in the Atmosphere Enabled by Advanced Processing Techniques for Existing Chromatographic Datasets. SUNGWOO KIM, Lindsay Yee, Allen Goldstein, Nathan Kreisberg, Gabriel Isaacman-VanWertz, *Virginia Tech*

Ambient aerosols may contain hundreds or thousands of unique organic compounds, and even minor components may provide valuable insight into particle sources and formation chemistry. However, due to the complexity of this data and the highly dynamic nature of aerosol composition, conventional analysis methods tend to be highly time consuming and also result in a substantial fraction of data never being analyzed or interpreted. We developed new methods to more comprehensively identify the full suite of analytes in a complex dataset by applying Positive Matrix Factorization (PMF) coupled with a peak-filtering decision tree. The analysis results find cataloged information of roughly 1000 potential analytes of interest. Single-ion chromatogram (SIC) based automatic peak fitting and integration method has been used to generate time series and complete the analysis cycle. This method requires a mass-to-charge ratio (m/z) that best represents the analyte peak signal, a quantifier ion, for integration process. An automated quantifier ion selection method based on peak resolution and signal intensity was developed for the completion of fully automated analysis process. In this presentation, we apply these methods to existing datasets collected by the Semi-Volatile Thermal Desorption Aerosol Gas chromatograph (SV-TAG) in Manacapuru, Brazil during GoAmazon 2014/15 campaign to identify new analytes and interpret their variability and transformations in the atmosphere. We apply two dimensionality reduction techniques, hierarchical cluster analysis (HCA) and spherical K-means, to the resulting analyte concentration time series to systematically investigate the underlying patterns of the observation and yield new insights into the sources of previously overlooked analytes. In particular, we aim to understand the characteristics of the categorized analytes in the context of atmospheric aerosol properties.

4MJ.6

Sunhye Kim, Ph.D. Candidate, Air Quality Project Manager. SUNHYE KIM, *Carnegie Mellon University*

As a committed Ph.D. candidate at **Carnegie Mellon University**, I specialize in studying the chemical characterization of particulate matter and volatile organic compounds within urban environments. I anticipate graduating in May 2024 and look forward to applying my passion and expertise in the roles of **Air Quality Project Management or Air Quality Consultant**, preferably within city areas.

My research focuses on **aerosols, urban air quality, measurements, and the impact of cooking organic aerosols.** This interest was sparked during my high school years when I led a group of students in researching cloud-seeding chambers, an effort recognized by the American Meteorological Society. During my undergraduate years, I further deepened my engagement with this field by establishing an atmospheric science academic club and participating in multiple engineering contests.

My education spans a bachelor's degree in **Environmental Science and Engineering**, a master's degree in **Public Health** in Environmental Health Sciences, and a Ph.D. in **Mechanical Engineering**, which I am currently pursuing. This multidisciplinary background augments my ability to interact effectively across different sectors, an essential skill for a Project Manager. **Real-world experiences** and **a Project Management Certificate** from Google's Coursera platform have honed my leadership and management skills. A testament to this was the successful revitalization of a dormant mobile laboratory used for air quality sampling in Pittsburgh. Despite a lack of guidance, strategic planning, effective delegation, and open communication led to the lab's full operation and the training of new graduate students in my group.

I am deeply appreciative of your consideration and if given the opportunity, am eager to employ my expertise and passion to make a significant, positive difference in the realm of air quality, while further honing my skills within your esteemed organization. I am excited about the prospect of leveraging my knowledge, practical experiences, and consultancy roles.

4MJ.7

Sudheer Salana, Ph.D. Candidate, University of Illinois at Urbana-Champaign, Seeking Postdoctoral Positions in Aerosol Measurements/Health effects. SUDHEER SALANA, *University of Illinois at Urbana-Champaign*

I am a fourth year Ph.D. candidate in Dr. Vishal Verma's group at the University of Illinois at Urbana-Champaign. My research focuses on the use of *in-vitro* and chemical assays to evaluate ambient $PM_{2.5}$ toxicity.

In the past four years I have worked extensively on different techniques to improve our understanding of biological effects of ambient $PM_{2.5}$ using various human and mammalian cell lines. I designed and developed a semi-automated instrument, the first of its kind, for measuring the cellular oxidative potential (OP) using rat alveolar macrophage cells (published in journal AMT). The instrument named SCOPE uses dichlorofluorescein diacetate (DCFH-DA) as a probe to detect the OP of PM samples extracted in water. I also worked on understanding the relationship between cytotoxicity and different methods to measure oxidative stress induced by PM. I was instrumental in establishing protocols for different biological assays in our lab and am proficient in using specialized instruments such as Flow Cytometer, ICP-MS, EC/OC analyzer and TOC analyzer. I am also well-versed in the programming language Python.

I have served as a TA for two different aerosol laboratory-based courses (one graduate-level and one undergraduate-level) in which I guided students in designing and executing projects involving indoor air quality measurements, setting up $PM_{2.5}$ sampling trains, $PM_{2.5}$ sample analysis, ACH calculations, use of low-cost sensors. I also demonstrated to and trained students on various aerosol measurement techniques using SMPS-CPC, OPS and other aerosol instruments.

Prior to my Ph.D. I worked for three years as a research fellow in the National Environmental Engineering Research Institute (NEERI) in Mumbai, India where I worked on numerous projects related to air quality including the design of an outdoor air purifier (WAYU), conducting CFD analysis and carrying out the performance testing of the device in the laboratory and field.

I am looking for postdoctoral opportunities in the field of aerosol measurements, toxicology, and health-effects of PM, anywhere in the US.

Anticipated availability: Summer/Fall 2024

Contact: ssalana2@illinois.edu

4MJ.8

Una Trivanovic, PhD Candidate at ETH Zürich, Seeking an Academic Position. UNA TRIVANOVIC, *ETH Zurich, Switzerland*

I began my graduate studies at the University of British Columbia supervised by Prof. Rogak researching the size and morphology of soot aerosols from marine engines using alternative fuels [1] and effects of fuel, water [2] and salt [3] on soot from gas flares. Currently, I am a PhD Candidate at ETH Zürich supervised by Prof. Pratsinis. During my PhD, I developed a method for generating aircraft-like soot by enclosed spray combustion (ESC) of various jet fuels [4]. This soot has similar mobility, primary particle size, d_p, organic carbon to total carbon ratio and effective density to that measured from real aircrafts. The large mass of generated soot allows for characterization of its specific surface area revealing that it is largely non-porous. To understand the dynamics of ESC-generated soot, flame temperatures and soot size distribution were measured within the flame and compared to previously validated models of soot agglomeration and surface growth [5]. At small heights above the burner (HAB) soot grew through surface growth. By HAB ~5 cm, agglomeration took over as the primary particle growth mechanism, also confirmed by constant Raman spectra at HAB >5 cm. Furthermore, a correlation was observed between the median d_p and Raman disorder to graphitic peak ratios indicating that soot with larger d_p had more ordered nanostructures. This trend was observed in previous work on soot from gas flares [2]. Thanks to the high-throughput of ESC, X-ray diffraction could easily be performed to corroborate this finding. Specifically, the soot crystallite length increased and its interlayer distance decreased as the median d_p increased. Such analysis leads to novel ways for reducing the soot generated by jet fuel combustion as my ongoing PhD research gradually reveals. I expect to graduate by early 2024 at which time I will be interested in an academic position.

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4MJ.9

Shuang Wu, Ph.D. Candidate in Environmental Atmospheric Chemistry, Postdoctoral/Industry Positions. SHUANG WU, *University of Alberta*

I am a Ph.D. candidate at the University of Alberta, pursuing a degree in Environmental Atmospheric Chemistry under the supervision of Dr. Ran Zhao.

My research focuses on the chemical partitioning process and exposure pathways of emerging indoor organic pollutants, including microbial volatile organic compounds (MVOCs) and flavor agents added to e-cigarettes. To better understand these processes, I have combined laboratory experiments and chemical modeling. Specifically, I have determined partitioning coefficients using Gas Chromatography with Flame Ionization Detector (GC-FID) and Nuclear Magnetic Resonance (NMR) spectroscopy and analyzed the resulting data using MATLAB and Python. Additionally, I have employed a chemical two-dimensional (2D) partitioning model to visualize the phase distributions of these emerging indoor organic pollutants and understand their potential pathways of human exposure.

My research has yielded significant findings, and I have published three first-author papers in peer-reviewed journals such as Environmental Science & Technology and Environmental Science: Processes & Impacts. I have also presented my research at various conferences, both through oral presentations and poster sections.

Prior to my Ph.D. studies, I completed my BSc and MSc degrees in Atmospheric Science from Nanjing University, where I participated in projects related to haze hazards, air quality, and urban climate planning. This experience helped me develop a strong background in atmospheric regional models and air quality models based on Fortran and Linux.

As I approach my expected graduation date of summer 2024, I am actively seeking postdoctoral or industry positions, with a preference for opportunities located in North America or Europe. I am a diligent researcher with a strong background in environmental and atmospheric chemistry, and I am eager to contribute my expertise to new projects.

4MJ.10

Wen Zhang, 5th Year Ph.D. Candidate, a Postdoctoral Research Position. WEN ZHANG, *University of California, Riverside*

I am Wen Zhang, a fifth-year Ph.D. candidate from the University of California, Riverside, and I plan to graduate in the Summer 2024. My research works on the potential interferences of popular analytical instrument of chemical ionization mass spectrometry (CIMS) to help eliminating the measurement misunderstanding of aerosol chemistry, as well as focuses on the heterogeneous kinetics and oxidation mechanism of various organic aerosol (OA) model systems which may reconcile the discrepancies between atmospheric observations and laboratory studies on organic aerosol aging.

In the first project (Zhang et al., Anal. Chem., 2021), we reported the occurrence of the secondary ion chemistry from interactions between a strong oxygen donor (such as O3 and peracids) and acidic OVOCs in the ion-molecule reaction (IMR) region of Iodide-adduct CIMS. The formation of such monomer and dimer clusters cause misinterpretations of molecular compositions and distributions of the gas-phase products and an overestimation of the elemental O/C ratio overall. My second project (Zhang et al., Environ. Sci. Technol., 2023) studied the heterogeneous OH-initialed OA aging using a continuous flow stirred tank reactor (CFSTR) to bring the laboratory [•OH] closer to the real atmosphere than typical flow tube reactors (FTR). We observed a chain propagation mechanism (i.e., autoxidation) in heterogeneous chemistry, causing OA oxidative aging of two to three orders of magnitude faster than previously reported. The following heterogeneous project will investigate on the oxidation kinetics and key oxidation products of •RO2 + •HO2 and •RO2 + NO bimolecular reactions. I also worked on another project of monoterpene-derived oxidation to characterize gas-phase •RO2 composition and particle-phase molecular-level SOA formation. In 2022, I wrote a review manuscript about recently developed mass spectrometry techniques for Mass Spectrometry Reviews.

After graduation, I plan to continue my study on atmospheric chemistry as a postdoctoral researcher for 1-2 years. I am looking forward to postdoctoral opportunities to continue my track in scientific research-related careers.

4MJ.11

Karolina Cysneiros de Carvalho, PhD Candidate Seeking Industry/Postdoctoral Positions.

KAROLINA CYSNEIROS DE CARVALHO, *Washington University in St. Louis*

Karol earned her bachelor's degree in chemical engineering from the Federal University of Pernambuco, Brazil, and Missouri University of Science and Technology. She is currently a PhD candidate in Energy, Environmental and Chemical Engineering at Washington University in St. Louis, at the Atmospheric Chemistry and Technology (ACT) Laboratory led by Dr. Brent Williams.

As a PhD researcher, Karol developed and characterized the ACT Semi-Volatile Thermal Desorption Aerosol Gas Chromatograph (SV-TAG). She deployed the instrument during the 6-week Alaskan Layered Pollution and Chemical Analysis (ALPACA) field project in the winter of 2022 in Fairbanks, Alaska. Her measurements aim to better understand aerosol phase partitioning in cold and dark conditions as well as indoor chemistry dynamics in residential homes in this environment. During her PhD, she also worked in the development of the Volatility and Polarity Separator (VAPS) and utilized this instrument to improve the knowledge about volatility distributions of secondary organic aerosols generated by the ozonolysis of different precursors. Karol has experience in operating several instruments including the Aerosol Mass Spectrometer, the Potential Aerosol Mass Oxidation Flow Reactor, and the Tandem Differential Mobility Analyzer.

Karol is expected to graduate in the Spring of 2024. She is seeking either an industry or a postdoctoral research position at national laboratories or universities. Her main research interests revolve around the chemical composition and physical characterization of indoor and outdoor aerosols and the development of novel instrumentation.

Geographical preference: USA
Preferred start date: Fall 2024
Contact: karolinac@wustl.edu

4MJ.12

Chun-Ying Chao, Current Ph.D. candidate in Environmental Engineering at Rice University, Seeking Postdoctoral position.

CHUN-YING CHAO, *Rice University*

My research focuses on in-situ measurements and data analysis related to weather impacts on aerosol composition and concentration. In my thesis, I performed a comprehensive analysis of: (1) the effectiveness of composition-dependent aerosol removal under various rain intensities; (2) the impact of aerosol composition on condensation sinks after rain events; and (3) the impact of sea breeze on aerosol levels using historical monitoring measurement of particulate matter in Houston.

In my Ph.D. study, I used the Aerodyne high-resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS) to measure aerosol during the TRACER-MAP and TRACER-AQ2 field campaigns in Houston. In addition to field campaign experience, I used Igor Pro, R, and positive matrix factorization (PMF) to process highly resolved spatiotemporal data and to employ source apportionment. I also analyzed long-term PM composition data in Houston using EPA-PMF. In my master's study, I applied low-cost PM sensor data to improve pollution mapping products.

Based on these experiences, I plan to use advanced data science tools in my future research in atmospheric chemistry; for example, I would apply machine learning to analyze AMS PMF results. This will introduce a novel idea for handling various source datasets to the scientific community.

My ultimate goal is to work as a professor in Taiwan or the USA. Therefore, I want to find a research group that can continue to expand my horizons. I am seeking a postdoctoral position in a research group focusing on atmospheric chemistry, field campaigns, or source apportionment. Currently, I am a Ph.D. candidate at Rice University working with Dr. Rob Griffin, and I expect to graduate in December 2024. Before joining Rice University, I completed my master's degree at Washington University in St. Louis under the guidance of Dr. Pratim Biswas.

4MJ.13

Weixing Hao, Ph.D. Candidate, Pursuing Postdoc/Faculty/Scientist Positions. WEIXING HAO, *University of Miami*

I am a fourth-year Ph.D. candidate in Dr. Yang Wang's group at the **University of Miami**, specializing in **air filtration, aerosol instrumentation, and aerosol health effects**.

My first project is to examine the filtration performance of common materials as candidates for homemade facemasks in COVID-19 mitigation. Due to the severe shortage of medical supplies, I evaluated the filtration performance of homemade masks by examining the filtration efficiency and breathability of more than 250 fabric and paper materials and sharing the data freely with the public. This work received coverage from several media, including the New York Times, BBC News, and NPR News.

The second project is to optimize the Condensation Particle Counter (CPC) performance in numerical simulation using COMSOL software. The simulation incorporated particle activation and droplet growth. The effects of operating conditions and working fluids on CPC performance are also discussed. The results of this study can be used for further optimizing the performance of CPCs for detecting sub-3 nm particles.

The third ongoing project is to dig deeper into how bioaerosols may evolve and transport in indoor environments. I set up a chamber to generate the suspension of bioaerosols to simulate human activities such as coughing, sneezing, and talking and analyzed the load and viability of pathogens in these bioaerosols. I also use the data we collected from the filtration experiments to design a simulated respiratory system with similar aerosol deposition compared to actual human lungs. This simulated system will simplify future health studies on smoke aerosols, reducing the risk and cost associated with human subject recruitment.

I plan to graduate by the end of 2024 and I look forward to staying in **academia** and contributing more to AAAR. For further questions, please contact weixinghao@miami.edu.

4MJ.14

Lu Zhang, Ph.D. Candidate at Peking University, Seeking a Postdoctoral Position. LU ZHANG, *Peking University*

I am a Ph.D. candidate in the College of Environmental Sciences and Engineering at Peking University in Beijing, China in Prof. Maosheng Yao's group. My doctoral research focuses on particulate matter (PM) components and associated toxicity at a national scale.

Current control standard of PM is solely based on mass levels, failing to consider their toxicity differences. My work has shown that particulate toxicity difference in the 31 major Chinese cities was up to 6.5 times partially arising from differences in both biological and chemical components. To further understand the health effects of PM with different compositions, a non-invasive protocol was explored by detecting exhaled VOCs. My work has showed changes in the release of VOC fingerprints both from human and eukaryotic model Saccharomyces cerevisiae after different PM exposure. Combined with proteomics and transcriptomics, the mechanism of VOC release changes at the cellular level is being explored. My work has enhanced the understanding of PM components and toxicity and developed a novel method for rapid in vivo monitoring human health impacts of PM exposure based on exhaled VOCs.

I have accumulated extensive experiences and research skills through my doctoral studies, such as programming languages (Python, R, MATLAB), machining learning models, microbiological and biochemical assays, toxicological analysis, etc. These studies resulted in my 3 first-author peer-reviewed papers and 2 first-author articles under review in top journals of the field, including Environmental Science & Technology and Environment International. Additionally, I have also been awarded the PKU President Scholarship, the highest honor for a graduate student at PKU.

I am now seeking a postdoctoral position that will allow me to further explore and contribute to the field of environmental and aerosol sciences. I am open to opportunities globally and possess no geographical limitations.

Preferred start date: Summer/Fall 2024
Contact: luzhang-ivy@pku.edu.cn

4MJ.15

Multiscale Modeling - Ella Ivanova. ELLA IVANOVA, *New Jersey Institute of Technology*

I am Ella Ivanova, currently in my fourth year as a Ph.D. student in Gennady Gor's computational laboratory for porous materials at NJIT. Given that I will be defending at the end of this year, I eagerly anticipate the opportunity to pursue my career as a molecular modeling specialist in chemical engineering and atmospheric phenomena research.

At present, I am actively involved in two major projects at NJIT. The first project focuses on investigating the restructuring process of atmospheric soot. These soot particles consist of fractal aggregates of hundreds of carbon spherical monomers, which undergo restructuring during atmospheric aging due to the condensation of various vapors on their surface. To tackle this challenge, we approach the problem from two angles. Firstly, we employ a thermodynamical approach to predict the restructuring based on environmental conditions numerically. Additionally, we utilize molecular dynamics simulations to gain insights into the driving forces behind the restructuring phenomenon. My second project involves predicting the thermodynamic and transport properties of chemical warfare agents (CWAs) and their simulants. Since CWAs often present in the form of aerosols, the surface tension and viscosity of liquid CWAs are among the key properties which determine aerosol evolution. To achieve this, we employ molecular dynamics simulations to predict the necessary properties; using molecular simulations allows one to minimize the number of costly and dangerous experiments.

Throughout my academic journey at Saint Petersburg State University and New Jersey Institute of Technology, I have contributed significantly to the field, publishing 13 papers and participating in 13 conferences. My expertise has led to invitations for peer reviews in renowned journals in the physical chemistry field. Furthermore, I had the honor of co-organizing the Molecular Simulation Workshop at NJIT in the Spring of 2023 and being a student coordinator for the summer research program 2023 with Bergen Community College. Also, I had the opportunity to teach guest lectures on ChE 775 (Molecular Simulations in Chemical Engineering), ChE 342 (Chemical Engineering Thermodynamics II), and ChE 365 (Chemical Engineering Computing). In addition to teaching experience, I have mentored undergrads and high school students each summer since 2020.

Presently, I am seeking a postdoctoral position in either industry or academia, with a primary interest in aerosol modeling.

4MJ.16

Darryl Angel, Ph.D. Candidate Pursuing Bioaerosol/Environmental Microbiology Postdoctoral or Research Scientist Positions within Government or Industrial Sectors. DARRYL ANGEL, *Yale University*

I, Darryl Angel, am a Ph.D. Candidate at in the Department of Chemical and Environmental Engineering at Yale University.

Prior to attending graduate school, I majored in Environmental Science as well as Geography at the State University of New York at Binghamton, where I was able to take coursework and conduct multidisciplinary research related to chemistry, physics, biology, geology, statistics, and geographic information systems. I began conducting collaborative research early on in my academic career when I joined a First-Year Research Immersion program, conducting materials science-based research with a team of peers. In addition to general research knowledge, I quickly learned a valuable skill- the ability to persevere past unforeseen challenged faced in the lab. Following FRI, I accepted a summer opportunity conducting biogeochemistry research and later transitioned into a collaborating geomicrobiology lab, completing an honors thesis studying novel pathways for bioremediation.

Upon the completion of my undergraduate education, I aimed to translate my research and professional career towards practical applications that facilitate impactful outcomes. Thus, I joined Dr. Jordan Peccia's Environmental Biotechnology Lab at Yale University. Here I conduct independent projects as well as collaborative efforts aimed at evaluating and mitigating human health exposure to bioaerosols. My doctoral research involves engineering chamber bioaerosol experiments, and culturing, collection (active and passive sampling), and analysis of airborne viruses from controlled chamber and environmental samples.

My experience to date has allowed me to learn a broad range of concepts, methods, and technical instrumentation in addition to universal skills including writing, presenting, communicating, and trouble shooting. Detailed technical skills are located in my CV.

I am happy to discuss collaborative bioaerosol/environmental microbiology postdoctoral or research positions within the government, national or state laboratories and job opportunities among the industrial sector. Willing to relocate.

Anticipated availability: Fall 2024

Contact: darryl.angel@yale.edu

4MJ.17

Sohyeon Jeon, PhD Candidate, Industry/Government/Postdoc Position. SOHYEON JEON, *Washington University in St. Louis*

I am currently a graduate student in the Department of Energy, Environmental, and Chemical Engineering at Washington University in St. Louis. My research focuses on understanding the chemical composition and properties of organic compounds of aerosols and developing a database tool and data processing method. I'm conducting chamber experiments to investigate gas-particle phase partitioning, particularly concerning indoor semi-volatile organic compounds depending on particles' physical and chemical properties. For this, I utilize measurement instruments, including two types of thermal desorption aerosol gas chromatography-mass spectrometers (TAG). Additionally, I have developed an aerosol mass spectrometer mass spectral database tool and automated quantification method for large GC-MS datasets.

My anticipated graduation is in July 2024. I am looking for positions in industry, government, and postdoc roles.

Interest topics: Atmospheric Science, Organic aerosols, Measurement, Data analysis

Skills:
-Instrument:
Gas chromatography-mass spectrometer (GC-MS)
Impactor-based Collection and Thermal Desorption TAG (ICTD-TAG)
Semivolatile thermal desorption TAG (SV-TAG)
Scanning mobility particle sizer (SMPS)

-Data handling:
Igor pro
Source apportionment models (PMF, binning PMF - especially for GC-MS data))
Chemstation

-Experiment design:
Laboratory chamber experiment to analyze chemical composition using mass spectrometers

Job interest: Industry/Government/Postdoc

Geographical preference: Open to any geographical location

Contact: sjeon@wustl.edu

4MJ.18

Jinglin Jiang, Ph.D. Candidate, Purdue University, Seeking Industry/Postdoctoral Positions. JINGLIN JIANG, *Purdue University*

I am a Ph.D. Candidate in Civil Engineering at Purdue University. My research interests span topics related to indoor air quality, including volatile organic compounds (VOCs), secondary organic aerosols (SOAs), indoor chemistry, and building ventilation.

My Ph.D. research focuses on how human activities and ventilation systems impact indoor air composition and chemistry. Specifically, my research aims to: 1.) characterize gas- and particulate-phase emissions during common indoor activities including disinfecting, cleaning and hair styling in real-time, and evaluate their impact on human health and the atmospheric environment; 2.) map the spatiotemporal distribution of gas-phase species in HVAC system in real-time. To achieve research goal 1.), experiments have been conducted in a realistic residential chamber to characterize the emissions from the use of various consumer products. I have evaluated the emissions and human exposures from the use of cleaning agents, disinfectants, and hair care products in different indoor environments. A proton transfer reaction time-of-flight mass spectrometer (PTR-TOF-MS) was used to monitor the mixing ratios of VOCs in real-time, and a complex array of particle sizers were used to monitor particles with diameters from 1 nm to 10 µm. To achieve research goal 2.), I have implemented a multi-point sampling system in an office building and its HVAC system to monitor spatiotemporal trends of VOCs and O_3 mixing ratios at different locations in the HVAC system in real-time.

I am expected to graduate in Spring/Summer 2024. I am seeking industry and postdoctoral opportunities in national laboratories or academic institutions, preferably in the U.S., Canada or Europe.

4MJ.19

Colby Buehler, PhD Candidate (Yale), Teaching/Research/Postdoc Opportunities. COLBY BUEHLER, *Yale University*

My name is Colby Buehler and I am currently a PhD Candidate at Yale University studying Environmental Engineering under advisement by Dr. Drew R. Gentner. I anticipate finishing my degree in Spring 2024 and being available in Summer 2024. My research has focused on low-cost air quality sensors and their ability to answer questions that traditional measurement techniques struggle with. After constructing a fleet of low-cost monitors for the Solutions for Energy, AiR, Climate, and Health (SEARCH) center, I have applied them to a variety of topics: representation error for global aerosol climate models, changes in the role of urban roadway emissions in Baltimore, and exposure to pollutants in homes, to name a few. Additionally, I have conducted modeling studies of indoor air quality and maintained FRM and FEM instruments at a coastal site in Connecticut as a part of the AEROMMA field campaign.

I am open to many different types of positions but I have a preference to those which afford teaching opportunities or to a post doc position or other research position in the area of low-cost sensors or urban air emissions. I have participated in many programs to teach high school students during my studies, mentored numerous undergraduate students on impactful research projects, and been a teaching assistant for chemical and environmental engineering courses. I am preferably looking for opportunities along the east coast of the United States but am open to other options. I look forward to discussing any and all opportunities, enjoy AAAR!

4MJ.20

Namrata Shanmukh Panji, PhD Student at Virginia Tech Seeking Government or Industry Roles. NAMRATA SHANMUKH PANJI, *Virginia Tech*

I am currently a fourth-year PhD student at Virginia Tech in the Department of Civil and Environmental Engineering and plan to graduate in May 2024. I also hold an undergraduate degree in Chemical Engineering. I am eager to pursue R&D opportunities in government and industry sectors.

My graduate work can be broadly divided into three main projects: (1) Development of a novel preconcentration technique for reactive organic gases in small sample flows, (2) Analyzing temporal trends in 4 years of hourly speciated biogenic volatile organic compound (BVOC) concentrations at a southeastern forest, and (3) Modeling emissions and simulating photochemistry using existing methods to reconcile observed trends. Evidently, my research focuses on dynamic BVOC and atmospheric interactions, and I have honed my skills to approach this in a comprehensive and multi-faceted fashion. I have developed skills to operate various instruments to measure gases and am also comfortable working with extensive datasets. Apart from working with research grade instruments, I have experience working with low-cost gas and particle sensors. Additionally, my expertise in emissions and atmospheric modeling has equipped me to make significant contributions to environmental research. Furthermore, I am incredibly passionate about bridging the science-policy gap.

My goal is to leverage my knowledge and passion to address environmental challenges and drive sustainability efforts. I am excited to collaborate with like-minded professionals and apply my expertise to real-world applications.

4MJ.21

Susan Mathai, PhD in Atmospheric Sciences, and Desired Position/Area: Post Doc/Scientist in the Field Related to Optical Properties of Aerosols Emitted from Biomass Burning.

SUSAN MATHAI, *Michigan Technological University*

My research focuses on the physical, chemical and optical properties of biomass burning aerosols. My initial project focused on setting up cavity enhanced extinction spectrometer that can measure the extinction coefficient of aerosols for a broad range of wavelengths (400 to 550 nm). We used the instrument in the laboratory to test if liquid smoke can be used as a surrogate for organic particles emitted during biomass combustion. During my internship at Pacific Northwest National Laboratory, I led three main projects. In the first project, we used electron energy loss spectroscopy to estimate the refractive index and other optical properties of tar balls transported through the free troposphere. Tar balls are formed during smoldering combustion and have wavelength dependent absorption. The second project was to study the physical and chemical properties of aerosols collected from an urban region with a high influence of biomass burning. We used Scanning electron microscopy, Scanning transmission X-ray microscopy and Transmission electron microscopy to understand the chemical composition and phase state of aerosols collected from a hazy condition. The third project focused on determining the radiative forcing of black carbon containing particles from the vertical profiles collected using the tethered balloon at the Southern Great Plains Atmospheric Radiation Measurement Site. My defense is planned for December 2023 and will be available to start a position from January 2024. I'm interested in Scientist or post doc position either in Academia or Industry with a focus on the optical properties of aerosols emitted from biomass burning. I don't have any geographical preferences for jobs.

4MJ.22

Chethani Athukorala, PhD Candidate / Post-Doc or Industry Research Position / Experimental Research. CHETHANI ATHUKORALA, *Clarkson University*

Bio: I am currently in my 5th year of pursuing a Ph.D. at AIR (Aerosol Instrumentation Research) Lab in Clarkson University working with Prof. Suresh Dhaniyala. My expertise is on conducting experimental studies to comprehend indoor aerosol generation, transport, and control. My work is published in two recent ASHRAE conference proceedings on indoor air quality and ventilation.

Interests: My research interest stems from a realization of the impact of poor air quality can have on human health, especially highlighted by the recent pandemic and its effect on lives worldwide. Consequently, I have been devoted to investigating various ventilation and filtration strategies to effectively curb disease transmission within indoor environments. My involvement in measuring PM2.5 levels during Canada's wildfires further solidified my commitment to finding solutions that promote cleaner and healthier air for everyone.
Driven by this passion, I have broadened my research focus to include policy-making in the context of infectious aerosols. My ultimate goal is to contribute actively to developing comprehensive solutions that address air quality challenges and play a crucial role in safeguarding public health.

Skills: Experimental designs : I design aerosol sampling systems to measure aerosol characteristics in real-world occupational settings using both research-grade aerosol measuring devices and low-cost sensors. My previous work includes experiments in aerosol generation, classification, and filtration systems.

CFD analysis : I have done CFD simulations for devices utilizing aerosol transport under gravity and electrostatics using ANSYS Fluent and some of my work is published in AS&T journal.

Troubleshooting aerosol sampling instruments : I involve in calibrating and troubleshooting aerosol sampling instruments including impactors, classifiers (eg. DMA-Differential Mobility Analyser) and aerosol sizing instruments.

Job interest: Post-doc/ Industry research positions

Preferred start date: Early 2024

Contact: athukocd@clarkson.edu

4MJ.23

Bethany Sutherland, Ph.D. Candidate at North Carolina State University (NCSU) Seeking a Postdoctoral Research Position.

BETHANY SUTHERLAND, *NC State University*

For my doctoral research, I have developed novel methods for an improved understanding of aerosol properties utilizing a combination of modeling and remote sensing. My work can be categorized into two main projects; one focused on air quality (surface $PM_{2.5}$ concentration estimation) and the other on the climatic role of aerosols (the direct radiative effect, DRE). My diverse experiences make me ideally suited to succeed as a postdoctoral researcher. Through my work at NCSU, and previously at Pacific Northwest National Laboratory, the University of Washington (M.S. in applied mathematics), Los Alamos National Laboratory, and New Mexico Tech (B.S. in physics) I have gained many valuable research and professional skills. I have experience with field campaign data collection (SECIONS, TRACER) and data analysis (DISOCVER-AQ, KORUS-AQ, etc.), as well as running and modifying 3D global models (GEOS-Chem, CESM). I have valuable professional experiences including writing funded NASA FINESST and NC Space Grant proposals, a first authored publication (with another in preperation and several co-authorships), and have presented my work at 11 national and international professional conferences.

My air quality project involved the development of several new methods for estimating surface $PM_{2.5}$ concentrations utilizing High Spectral Resolution Lidar (HSRL)-derived aerosol types to inform on the likely chemical speciation and hygroscopic growth of particulates. These novel methods show promising results when applied to campaign data and compared to models. My DRE project is forward-looking and proposes a new method for estimating DRE that uses aerosol type-specific optical properties and HSRL-retrievals. This method could be implemented once a HSRL-like system is spaceborne and a modified version of GEOS-Chem is used to estimate the likely uncertainty.

I will be available for a new position fall 2024 and am excited about research positions that further our understanding of the role of aerosols in the climate system.

4MJ.24

Purushottam Kumar, PhD Student (Virginia Tech), Seeking R&D Opportunities in Research Labs or Industry Sector.

PURUSHOTTAM KUMAR, *Virginia Tech*

I am currently a 4th-year PhD student at Virginia Tech in the Department of Civil and Environmental Engineering with an expected graduation date of August 2024. I have an undergraduate degree in Chemical Engineering (graduated in 2017). My research interests include the design, development, manufacturing and deployment of new research-grade instruments for studying aerosols and VOCs.

During my PhD, my primary focus has been the development of the “ChemSpot” instrument. The instrument combines the robust GC detectors (e.g. FID, FPD) with a CO_2 detector to measure volatility-resolved organic carbon, total sulfur content and estimate the average O:C of the aerosols. At present, the measurement of O:C is done using mass spectrometers which are usually highly expensive and of extreme complexity. Therefore, the ChemSpot instrument provides an alternative for aerosol composition albeit less detailed than mass spectrometry but still provides very useful information at much lower costs of operation, and complexity of analysis which makes long-term data collection feasible. The instrument description manuscript is under preparation. The other part of the ChemSpot development has been to check the feasibility of studying 1D and 2D-VBS using the ChemSpot instrument. The ChemSpot instrument was also deployed at a wildfire simulation study in Georgia alongside multiple instruments and the analysis of this dataset is currently underway. Apart from the ChemSpot development, I am working on the data analysis of anthropogenic VOCs at a forest site in Virginia. Before starting my PhD, I was involved in the continuous operation of multiple instruments which included AMS, ACSM, Thermo gas analyzers, SMPS, Aethalometer, etc. for two years collecting data on Delhi air pollution.

I am eager to pursue R&D opportunities primarily in research labs and industry sectors. I have had extensive training and experience with research-grade instruments so my preference is more towards the development of new instruments, particularly mass-spectrometers. I do not have any geographical limitations.

4MJ.25

Paulus Bauer, PostDoc in Physical Chemistry UC Irvine, Looking for Job in R&D or Teaching. PAULUS BAUER, *University of California, Irvine*

My name is Paulus Bauer and I am currently a postdoc in the ultrafine aerosol group of Prof. James Smith at UC Irvine (Chemistry department). Studying particles emitted by brake and tire wear and attempting to reveal the chemical composition of particles smaller than 10 nm are my main foci. My research interest into nanometer sized aerosol particles and their formation processes got sparked during my PhD thesis at the University of Vienna (Physics department), Austria, where I measured nanometer-sized aerosol in-situ with synchrotron-based Small Angle X-ray Scattering (SAXS). During my PhD and postdoc at the University of Vienna, I gained a lot of knowledge from my teaching duties and by designing a new lecture series. My talent in developing new tools and instrumentation evolved during my physics master at the University of Heidelberg and also working in my father's workshop, who is a musical instrument builder.

I am looking for a position in environmental research, in developing new tools and measurement techniques or in teaching positions in environmental related sciences. My anticipated availability will be in April 2024 and I am looking forward to explore new geographic locations.

4MJ.26

Tori Hass-Mitchell, Ph.D. Candidate at Yale University in Chemical and Environmental Engineering, Seeking Industry/Government/National Lab Positions. TORI HASS-MITCHELL, *Yale University*

I am a Ph.D. candidate pursuing a degree in Chemical and Environmental Engineering at Yale University supervised by Dr. Drew Gentner.

My research focuses on the emissions, corresponding sources, and chemical evolution of complex mixtures of functionalized organic compounds, specifically as they contribute to urban aerosol-phase air pollution. I investigate these species through a mix of online and offline methods, namely, aerosol mass spectrometry and high-resolution tandem mass spectrometry. Through this work, I have participated in multiple field campaigns and observational networks, most notably, the NYC-METS campaign in summer 2022, the AEROMMA campaign in summer 2023, and the ASCENT network from spring 2022 to present day. My first project resulting from these campaigns (Hass-Mitchell et al., Atmos. Chem. Phys., in review) leveraged summer 2022 online aerosol measurements from two NYC sites to determine that SOA is the now dominant fraction of summertime aerosol in NYC, and it is also highly temperature-dependent. This has vast implications given the expected greater health effects of SOA and the influence of increased chemical age on cellular toxicity, especially under warming climate conditions. A second ongoing project will utilize summer 2022 and 2023 offline filter measurements and aims to achieve molecular-level speciation of highly functionalized urban aerosols, which is critical for determining their human health effects and informing related policy. Past interesting projects, albeit unrelated, include research on third-hand smoke and Canadian oil sands emissions.

Prior to graduate school, I completed an ABET-accredited chemical engineering degree at Yale University, during which time I joined Drew Gentner's lab as an undergraduate researcher. I then stayed on for an additional year as a post-baccalaureate researcher before beginning my Ph.D.

I am interested in opportunities in industry, government, and national labs located within the US.

Anticipated availability: Fall 2024

Contact: tori.hass-mitchell@yale.edu

4MJ.27

Jo Machesky, Ph.D. Candidate at Yale, Seeking Post-doctoral or Full-Time Government or Industry Positions. JO MACHESKY, *Yale University*

I am a Ph.D. candidate at Yale University, advised by Dr. Drew Gentner. As combustion-related emissions have declined over the past decades, non-traditional sources play an increasingly important role in urban and downwind air quality. These sources contain a larger fraction of functionalized gas-phase compounds containing oxygen, nitrogen, or sulfur, which are historically challenging to measure.

My Ph.D. has focused on employing top-down and bottom-up approaches to identify emissions from some of these sources, including cooking and materials in the built environment. For a subset of studied sources, I speciated the gas and particle-phase oxidation products. When possible, I explored the different functionalities of compounds emitted from these sources, such as variations in nitrogen-containing functional groups from different cooking sources.

During my time in the Gentner lab, I have enhanced our offline analytical capabilities by developing and refining methods for our multiphase sample collection of gas- and aerosol-phase compounds and analysis via liquid and gas chromatography coupled with time-of-flight tandem mass spectrometry for speciation of complex mixtures of organic compounds. Furthermore, I gained valuable experience through collaborations with Aerodyne Research Inc, where I utilized oxidation flow reactors for simulated atmospheric aging and employed multiple online techniques, notably iodide chemical ionization mass spectrometry, both in field and laboratory settings.
Looking ahead, I am enthusiastic about applying my expertise and acquiring new skills to investigate emerging atmospheric chemistry questions. My passion lies in interdisciplinary research, and I aim to find a position that fosters collaboration and communication across disciplines to achieve shared scientific goals. As a researcher, I recognize the importance of mentorship and successfully mentored numerous undergraduate projects. Thus, I am seeking roles that prioritize early career mentorship and offer opportunities for me to engage in community or undergraduate/graduate mentorship.

Geographically flexible

Anticipated availability: June 2024

Contact email: jo.machesky@yale.edu

4MJ.28

Alexander B. MacDonald, Postdoc at UC Riverside Pursuing a Career in Government or Industry. ALEXANDER B. MACDONALD, *University of California, Riverside*

I am currently a postdoctoral researcher at the University of California, Riverside (UCR). My background is in chemical engineering (undergraduate studies at Universidad La Salle México, and graduate studies at the University of Arizona (UA)). My doctoral research at UA, under the supervision of Dr. Armin Sorooshian, focused on aerosol-cloud interactions. I participated in two Navy Twin Otter aircraft campaigns studying the stratocumulus cloud deck off the California coast, and the NASA Cloud, Aerosol and Monsoon Processes Philippines Experiment (CAMP^{2}Ex) campaign in the Philippines. I extensively analyzed the composition of cloud water collected onboard these aircraft campaigns using ion chromatography (IC), which resulted in two first-author publications. Also as a graduate student at UA, I participated in the NASA Student Airborne Research Program (SARP) as the aerosol mentor twice (2019 and 2020), where my responsibility was to guide a total of 14 undergraduate students develop aerosol-related research projects. My postdoctoral research at UCR, under the supervision of Dr. Roya Bahreini, has focused on two projects examining secondary organic aerosol (SOA) with extensive use of aerosol- and gas-phase measurement instruments including an aerosol mass spectrometer (AMS). The first is a National Science Foundation (NSF) funded project studying the morphology of secondarily produced brown carbon particles. The second is a California Air Resources Board (CARB) funded project comparing the chemical composition of ambient aerosol in Riverside and Long Beach, California; these data were collected over three one-month field campaigns. My professional goal is to work for an organization (government or industry) that strives to understand, prevent, and mitigate air pollution and climate change. I enjoy working as part of a team to solve interesting and relevant environmental problems. I am available to start work once my postdoc contract ends mid-June 2024, with no geographical preference within the USA.

4MJ.29

Tania Gautam, PhD Candidate, University of Alberta, Pursuing Industry/Government Postdoctoral Positions. TANIA GAUTAM, *Pacific Northwest National Laboratory*

I am a 5th year PhD student in the department of analytical chemistry at the University of Alberta (U of A) in Dr. Ran Zhao's group. I am currently employed at the Pacific Northwest National Laboratory as a PhD intern under Dr. Swarup China's group in the Environmental Molecular Sciences Laboratory (EMSL) division. Analytical methods such as mass spectrometry are widely utilized in characterization of organic aerosols. My current research at PNNL involves application of nanospray desorption electrospray ionization (nano-DESI) coupled to high-resolution mass spectrometry (HRMS) to acquire molecular level characterization of organic compounds collected on teflon filters during TRACER field campaign in Houston, Texas. My recently published work from my PhD focused on the application of advanced analytical techniques (e.g., iodometry-LC-MS) in determining elusive reactive intermediates such as organic peroxides through novel formation pathways i.e. autoxidation in atmospheric aqueous matrices.

While I was an undergraduate student at U of A, I had amazing internship opportunities at industrial (ALS Global, 2016) and governmental (National Research Council, 2018) institutions. Through this work experience, I have gained hands-on experience in analytical instrumentation including operation/maintenance. I am equipped at data management using software analysis with Igor Pro, R and matlab. Given my background in chemistry, I am looking forward to exploring the application of analytical techniques in determination of reactive radical intermediates (e.g., RO_2, $O_2^{\cdot -}$, $^1O_2$) originating from biomass burning aerosols. With recent wildfires in North America, I am highly motivated in applying a combination of MS and resonance based methodologies (e.g., EPR) to determine the transformation of radical intermediates by understanding fundamental reaction pathways. My anticipated graduation is May 2024 and I will be available for full time positions starting August 2024 for companies located within North America. Please contact me at tgautam@ualberta.ca

4MJ.30

Medinat Akindele, PhD Candidate in Civil and Environmental Engineering; Research Positions in Environmental Engineering and/or Environmental Policy. MEDINAT AKINDELE, *Carnegie Mellon University*

My research interests are air quality, climate change, and environmental policy. Through my PhD, I have gained experience in air quality modeling. I developed the Rapid Estimation of Air Concentrations for Health (REACH) reduced-complexity model. REACH is a location-agnostic Gaussian plume model with chemistry. It predicts ambient PM2.5 concentrations and health damages (premature mortalities per tonne of PM2.5 emitted). The health damages can be applied to policy scenarios to predict premature mortalities from ambient PM2.5 exposure. They can help policymakers with benefit-cost analyses to make informed decisions to improve public health. I applied and evaluated REACH for the United States and Southern Africa. I am also training to learn how to run chemical transport models for an East Africa thesis project. I am interested in government, industry, and postdoc research positions. My anticipated availability is July-August 2024, with preferred job locations on the East Coast or Midwest in the US, but open to considering other locations.

4MJ.31

Abhishek Anand, PhD Candidate at Carnegie Mellon University, Seeking Postdoctoral Positions in Aerosol Measurement and Modeling that Includes Machine and Deep Learning Models. ABHISHEK ANAND, *Carnegie Mellon University*

I am a fourth year PhD student in the Department of Mechanical Engineering at Carnegie Mellon University. I am working under the mentorship of Prof. Albert Presto. My research interests revolve around advancing air quality monitoring in regions with limited resources, with a specific focus on developing low-cost methods to augment air pollutant datasets.

My PhD research overall focuses on developing low-cost methods to add air pollutant dataset in regions with limited resources for continuous and effective air quality monitoring. I have developed a Computer Vision-based method to extract hourly BC data from existing Beta Attenuation Monitors (BAMs). We are currently gathering BC data from a few locations in the Global South, particularly in Sub-Saharan Africa. I am currently engaged in the next phase of my research, which involves salvaging tapes containing particle deposits from these existing BAMs to measure organics and refractory inorganic components of $PM_{2.5}$ using an aerosol mass spectrometer.

My passion for applications of machine and deep learning in aerosol science drove me to utilize 5 years of low-cost sensor data for development of a deep learning-based $PM_{2.5}$ level forecast model for Pittsburgh. The model utilizes data from a network of 50 sensors in Allegheny County, thereby providing valuable insights for improving air quality.

As I am on track to defend my PhD thesis by May 2024, I am actively seeking postdoctoral positions in the United States, particularly at universities and national laboratories in the United States. My keen interest lies in aerosol modeling, where I can further explore the integration of machine and deep learning tools to address critical air quality challenges. My anticipated availability for postdoctoral positions begins from June 2024 onwards. This conference presents an excellent platform for me to share my research accomplishments and expertise with potential employers from academia, government, and industry.

4MJ.32

Kaitlyn McKinney, Research Assistant/Ph.D. Student in Civil Engineering Looking for Careers in Feild Research or Data Science. KAITLYN MCKINNEY, *Texas Tech University*

I am currently involved in an NSF-funded research project focused on studying wintertime air quality in central Alaska. I work with data collected from various instruments and construct mathematical models to gain insights into the ambient particulate matter measured throughout the study. I am interested in continuing to conduct field research in my future career. It would be exciting to apply the skills and knowledge I've gained from my current project to any future research I participate in. I have experience working in harsh conditions, manufacturing specialty equipment for fieldwork, and properly collecting field samples for lab analysis. Though my experience is mostly based in near arctic regions, I am open to the idea of working anywhere across the globe. In addition to field research, I also enjoy working in data analytics. The skillsets I've gained from data modeling can be applied to many fields. In a future project, I can work with any dataset to construct a series of mathematical models to understand the nuances of the data. I am also interested in the system modeling or holistic modeling side of data analytics. These are just some general areas I am interested in working in. The main thing I look for in a future career is that the work I am doing will improve people's lives or positively impact environmental health. I am open to working in new areas and fields, especially if I can work towards creating a better world for future generations. I hope to graduate by the end of summer 2024 and would be thrilled to start working as soon as I complete my Ph.D.

4MJ.33

Saravanan Kanagaratnam, Teaching Assistant/Doctoral Degree/Faculty Position, Government, and Industry/Ohio, Pennsylvania, Kentucky, Indiana, West Virginia, and North Carolina. SARAVANAN KANAGARATNAM, *Texas Tech University*

I am a highly skilled and knowledgeable aerosol and air quality researcher with a strong record of fieldwork and data analytics. I am involved in an air quality improvement collaborative project in North Pole City, Alaska, during extreme cold weather conditions, which is funded by NSF. The objective of our research is to identify the key factors contributing to air quality, especially during cold weather. I possess extensive fieldwork experience and have the capability to conduct campaigns in extreme weather conditions. My current focus is on identifying the source contribution to black carbon and understanding the absorption contribution from black carbon and brown carbon to the total absorption. I am well-versed in using various instruments such as Aethalometer, Total Carbon Analyzer, DustTrak, SEMS and MCPC, and WIBS-NEO5. Additionally, I have expertise in filter sampling using Mini volume samplers and High-volume samplers, including filter preparation and preservation. Furthermore, I have participated in a project involving low-cost PM2.5 sensors that utilized I2C communications with Arduino programming to measure ambient concentrations. I have also utilized PurpleAir sensors to study indoor air quality. In my future research, I intend to focus on identifying the source contribution to organic carbon and radiative forcing modeling of carbonaceous aerosols. I am proficient in using R-program, N-logit, and Stata for data analysis. I possess strong leadership skills and can coordinate research teams effectively with minimal guidance. I am expected to graduate in the summer of 2024, and my availability for potential positions will be from mid-August 2024 onwards. I am particularly interested in faculty positions within academia, as well as opportunities in government and industry. Regarding location preferences, I would ideally like to work in Ohio, Pennsylvania, Kentucky, Indiana, West Virginia, or North Carolina.

4MJ.34

Dr. Sunil Kumar; Current Position - Associate Research Scientist, Specialization – Thermal & Fluids Engineering; PhD – Nuclear Engineering. SUNIL KUMAR, *Texas A&M University*

Desired Position – Assistant Professor, Research Scientist, Engineer; Desired Area(s) – Aerosols Dispersion, Computational Fluid Dynamics, Process Optimization, Thermal Hydraulics, Thermal Management, and Energy Storage

Throughout my research career, I have embarked on eight diverse and significant projects, covering a wide range of scientific research and engineering applications. Project-1 focused on developing and characterizing Gas Electron Multiplier (GEM) detectors, with applications in particle physics experiments at CERN and practical uses in radiography and medical diagnostics. Project-2 involved designing electronic notch filters for a double Penning trap mass spectrometer, aiming to enhance mass measurement precision by suppressing unwanted ion species. In Project-3, I addressed the task of mitigating thermal stratification in a water pool with shrouds, proposing non-leaking shroud plates to delay pool saturation during a Station BlackOut condition in nuclear reactors' passive safety systems. Project-4 aimed at improving dry cooling platforms' efficiency using Latent Heat Thermal Energy Storage Systems with Phase Change Materials (PCM), enhancing the resiliency and reliability of dry cooling systems. Project-5 investigated the impact of meniscus shape on the local permeability of micropillar arrays, providing insights into heat transfer enhancement in electronic devices and optimizing flow conditions. In Project-6, I used CFD simulations to predict droplet dispersion during a sneeze event in a hospital room, exploring HVAC configurations and air curtains to mitigate airborne spread of diseases like COVID-19, offering valuable insights for safer public spaces. Project-7 introduced a novel CFD model to understand indoor airflow and droplet spreading patterns in meat processing plants' fabrication rooms, contributing to assessing infection risks for workers and stationary objects. Project-8 aimed to increase energy efficiency in cotton conveying and drying processes through CFD modeling, optimizing conveyor belt systems during cotton drying and contributing to more efficient ginning practices. These groundbreaking research endeavors have fueled my passion for pushing boundaries of scientific knowledge and practical applications, and I eagerly anticipate undertaking new challenges to continue driving innovation and progress in the fields of science and engineering.

4MJ.35

Yuhan Yang, Ph.D. Candidate, Pursuing Postdoc/Scientist Positions. YUHAN YANG, *Georgia Institute of Technology*

My name is Yuhan Yang. I am a fifth year PhD student from Georgia Institute of Technology working with Dr. Rodney Weber. My research interest is **aerosol effects on health**. Specifically, my PhD research overall focuses on **transition metals in aerosols and aerosol oxidative potential (OP).**

My past research includes developing a cost-effective spectrophotometric method to measure various forms of Fe and Cu in PM precisely and developing an ultrafiltration method to characterize the water-soluble composition of $PM_{2.5}$. Currently, I am involved in an intriguing project assessing indoor and outdoor oxidative potential of $PM_{2.5}$ in Fairbanks winter. I conducted an in-depth analysis of ambient $PM_{2.5}$ samples collected during winter pollution events in Fairbanks to assess their OP and used machine learning techniques to establish models linking $PM_{2.5}$ exposure and toxicity to specific chemical species. Moreover, I conducted a comprehensive comparison of PM oxidative potential across diverse regions, highlighting the adverse health effects attributed to emissions from both traffic sources and biomass-burning activities, and illustrated the distinct perspective on particle toxicity provided by OP, offering valuable insights beyond $PM_{2.5}$ mass.

Looking ahead, my passion for aerosol research drives me to **explore larger-scale aerosol health effects.** I am particularly enthusiastic about integrating my expertise in metals and OP with global or regional atmospheric models. Additionally, I am eager to undertake epidemiological studies that establish links between transition metals in PM and specific diseases. With my master's degree in statistics from Georgia Tech, I possess a comprehensive understanding of both traditional statistical methods and machine learning tools. My background in aerosols, knowledge in math and statistics, and skill in programming would enable me to contribute to future aerosol health effects research on a larger scale.

As my PhD thesis defense is scheduled for December 2023, I am seeking postdoctoral or scientist positions in the United States beginning **January 2024** onwards. Please contact me at **yhyang611@gatech.edu** if you are interested in collaborating or require more details.

4MJ.36

Eloise Parry-Nweye, Ph.D. Candidate in Chemical Engineering, Seeking Industry/Government/Postdoc Position. ELOISE PARRY-NWEYE, *Syracuse University*

I am a 5th year Ph.D. Candidate at the College of Engineering & Computer Science, Syracuse University, NY. I also successfully completed the coursework requirement with a GPA of 3.81/4.00. Previously, in 2018, I received my Bachelor of Science (B.Sc.) in Chemical Engineering from the Swanson School of Engineering, University of Pittsburgh, PA. Additionally, in 2019, I obtained my Engineer in Training (EIT) license and certification in New York. A copy of my engineering certification (Certificate #: 094198) can be found at https://account.ncees.org/rn/1989635-1172170-7c0c08a.

My doctoral research is in understanding the synergistic effects of environmental factors (TVOCs, humidity) and material properties on viral persistence. In my most recent study, I investigated the humidity-dependency of viral persistence on porous materials. Previously, I established effective sampling methods for viral aerosols which I deployed towards evaluating the efficacy of varied air cleaning technologies in removing infectious virus from air. In addition, I studied the interaction of TVOCs with viral aerosols under ambient conditions, as trace VOCs are inevitably emitted from building materials into indoor air. My experiments have been conducted in a full-scale aerobiological chamber which simulates a realistic indoor environment.

I will be presenting my research, “Persistence of Phi6, a SARS-CoV-2 Surrogate, in Simulated Indoor Environments: Effects of Humidity and Material Moisture Adsorption”, during the AAAR 41st Annual Conference **Special Symposium**, “Aerosol Science and Infectious Disease: Infectious Bioaerosol Fate”, on Thursday.

Given my scholarly, professional, and extensive research experience in the fields of **bioaerosols**, infectious diseases, and biochemical engineering, I am seeking industry/government/postdoc positions to continue to leverage my expertise and add value.

Graduation: December 2023
Anticipated availability: **January 2024**
Willing to relocate: Yes
Geographical preference: USA
Email: **eeparryn@syr.edu**
LinkedIn: linkedin.com/in/eloise-parry-nweye-405b04109

4MJ.37

Prince Vijay, Ph.D. Candidate (IIT Bombay)- Environmental Engineering-Air Pollution. PRINCE VIJAY, *Indian Institute of Technology Bombay*

Ph.D. candidate (IIT Bombay)- Environmental Engineering-Air Pollution, M Tech (IIT Madras-Newcastle University, United Kingdom)- Civil and Environmental Engineering-Air Pollution

Seeking post-doctoral positions, industry research, experimental research, academia (faculty position/lab head), project managers.

I am currently a Ph.D student Indian Institute of Technology, Bombay (IITB), Mumbai, India. My background is in Civil and Environmental engineering where undergraduate studies was completed at College of Engineering, Trivandrum, Kerala and masters at Indian Institute of Technology, Madras (IITM). My doctoral research at IITB, under the supervision of Dr. Harish C Phuleria, focusses on air pollution and its health effects. This is the first cohort study in India focussing on 1500 adult women spread across three metropolitan cities which are facing high levels of air pollution. The aim of this study is to measure the long-term exposure to air pollution and to develop predictive air pollution exposure models. From this work, till date, we have about three international achievements which are ICOH best poster award, ISEE-AWPC membership award and ISIAQ student travel award. During my masters, we developed and evaluated the performance of two Gaussian-based air quality models, namely ADMS and AERMOD models for Chennai city in India and Newcastle City in United Kingdom. This was the first study where two models were compared between two countries having different geographical factors and extremely different meteorological conditions. From this work, I have published three international conference papers, out of which one I have presented and won the Best Paper Award in an International conference jointly organized by IIT Madras, IIT Delhi and Newcastle University held at IIT Delhi. During master's degree, I was the first PG student who got an opportunity to go outside country and work with research group at Newcastle University. I will be privileged to pursue a post-doctoral degree anywhere across US and fulfil my ambition and continue as a competent researcher. I am available to start work once my Ph D tenure successfully ends around August 2024 anywhere across USA with no geographical preference within the USA.

4MJ.38

Brooke L. Smith, PhD Candidate at Texas A&M University, Pursuing a Career in Government or Industry . BROOKE SMITH, *Texas A&M University*

I am currently a 4th year PhD candidate at Texas A&M University in the Department of Biological and Agricultural Engineering. I completed my undergraduate studies at North Carolina A&T State University where I studied Biological Engineering with a concentration in Natural Resources Engineering. During undergraduate studies I developed my interest in microbiology and molecular biology. My first microbiological research experience was in a summer research program through the College of Engineering at Texas A&M University where I began the research that soon became my dissertation topic. After undergraduate studies I joined Dr. Maria King in the Aerosol Technology Laboratory at Texas A&M University to continue in my interests in microbiology, infectious diseases and antibiotic resistance in bioaerosols.

Currently my work is focused on bacterial behaviors in response to aerosolization stress, especially in relation to antibiotic resistance development and mechanisms. In my research I aerosolize gram-negative and gram-positive bacteria into an airtight temperature and relative humidity chamber and collect the bioaerosols using a wetted-wall cyclone bioaerosol collector. I compile environmental data such as the temperature, relative humidity and droplet characterization to monitor the environmental stressors bacteria experience. As a result, I am able to analyze culturability, phenotypic changes, antibiotic resistance development, and expression of antibiotic resistance genes.

In addition to experiments I used molecular modeling (MD) to visualize the activity of bacterial proteins-ligand interactions involved in antibiotic resistance mechanisms when in contact with antibiotics and coping with environmental stressors.

I am very passionate about research and development and science policy specifically in relation to infectious disease mitigation and biosecurity.

I will be available to start employment in mid-August 2024 with preference to government or industry opportunities.

Defense Date: June 2024
Graduation Date: August 2024
Email: blsmith5@tamu.edu
LinkedIn: https://www.linkedin.com/in/brooke-smith-66036b135

5AC.1

Characterizing the Rate of Water Diffusion in Viscous Particles and Gels Containing Organic and Inorganic Material.

CRAIG SHELDON, James F. Davies, *University of California, Riverside*

Aerosols are generated from a wide range of natural and anthropogenic sources. The physical state of an aerosol particle is primarily determined by the relative humidity (RH) and temperature of the environment and the particle composition. As RH decreases, aerosol particles can transition to a wide variety of physical states and morphologies that uniquely impact light scattering and mass transport. The properties of viscous amorphous particles and phase separated core-shell and partially engulfed morphologies have been studied extensively. Recent work has demonstrated the importance of gel formation in particles containing mixtures of organic and inorganic material. A gel state is a porous solid network with liquid entrained in the pores, limiting the transport of material to slow percolation through the pores that penetrate throughout the particle. Unlike in the formation of viscous particles, gel formation is a phase transition and, as such, particles can exhibit a more distinct change in properties as RH decreases, increasing the importance of understanding the RH response of these systems.

Here, we focus on the rate of water diffusion in gel states as a proxy for molecular diffusion in general. We probe the response of a single levitated particle to instantaneous RH steps of 1% using a linear-quadrupole electrodynamic balance coupled with Mie resonance spectroscopy. By tracking the position of individual morphology-dependent resonances in the spectrum over the particle response, the rate of diffusion may be estimated from the half-life response and the particle radius.

This method provides a simplification over other methods for characterizing water diffusion by reducing the extent of perturbation in RH, allowing D to be assumed constant over the course of the measurement. We present an exploration of the water diffusion in organic aerosols and the influence of adding inorganic co-solutes, such as CaCl2 and ammonium sulfate, both of which have been shown to produce significant ion-molecular interactions that lead to large and unexpected changes in viscosity and diffusion rates. Our results show a slowing of water diffusion, correlating with changes in viscosity, in some systems, while in others the properties are decoupled, attributed to the formation of a gel state that imposes additional constraints on mass transport. Molecular diffusion is a controlling factor in the heterogeneous reactivity of aerosol particles and lifetime of chemicals in the atmosphere that is not fully accounted for in atmospheric models.

5AC.2

Investigating Influence of Particle Size on Viscosity.

SUNANDAN MAHANT, Jefferson Snider, Markus Petters, *North Carolina State University*

Many atmospheric aerosol particles can be said to be amorphous and with physical compositions defined as liquid, semisolid, or glassy. The phase state influences gas-particle partitioning, chemical aging, and ice nucleation, and in turn modulates the role of aerosols on human health and climate. The amorphous phase state has been known to be highly dependent on particle composition, temperature and relative humidity for (secondary) organic aerosols. This study focuses on understanding the effect of particle diameter on the phase state. A differential mobility analyzer coupled with an optical particle spectrometer and a tandem differential mobility analyzer were used to probe the transition temperature of organic aerosol mimics. The temperature at which phase state changes is referred to as the transition temperature, and corresponds to where the viscosity is ~10^7 Pa s. Using the Angel scaled fragility, it is shown that viscosity decreases by 4 orders of magnitude as the size of sucrose particles decreases from 200 nm to 30 nm. The decrease in viscosity is anticipated by recent theoretical models describing the dependence of viscosity as a function of particle size. These measurements are expected to improve overall understanding of aerosols and refine existing phase state models.

5AC.3

Properties of Surfactants in Size-Resolved Atmospheric Aerosol Particles.

AMANDA FROSSARD, Tret Burdette, Rachel Bramblett, Kathryn Zimmermann, *University of Georgia*

Surfactants are a class of organic molecules that significantly reduce surface tension at an interface. In atmospheric aerosol particles, surfactants can affect the hygroscopicity of the particles as well as their surface tension and ability to act as cloud condensation nuclei. In this study, we investigate the sources and properties of surfactants in atmospheric aerosol particles collected at Skidaway Institute of Oceanography in summer 2018. Particles were collected in ten size ranges, and organic compounds were extracted from the particles using two solid phase extractions. The major ions in the particles were measured using ion chromatography. The extracted organic fractions were characterized with high resolution time of flight mass spectrometry and tensiometry. During this study, particles were collected from three air mass source regions: Marine Influenced, Mixed, and Continental Influenced. Here, we show that the signatures of the organic extracts as well as their surface tensions vary as a function of particle size and air mass source regions. Across all particle types, the ratio of hydrogen to carbon (H/C) was higher in the submicron particles compared to the supermicron particles, indicating different organic species in the smaller particles. The surface tension minimums were also lower in the submicron particles, demonstrating stronger or higher concentrations of surfactants in the submicron particles. Chemical formulas were identified to be surfactant-like based on their relative ratios of hydrogen, carbon, oxygen, sulfur, and nitrogen. The fraction of surfactant-like formulas was negatively correlated with minimum surface tensions, demonstrating that as the surfactant fraction increased, the surface tension decreased. Additionally, formulas identified as fatty acids had longer carbon chain lengths in the Marine Influenced particles (18) compared to the Mixed (15) and Continental Influenced particles (9), which may indicate different sources of fatty acids or aging in the atmosphere that breaks down the fatty acid carbon chains.

5AC.4

Exploring the Phase Behavior of Biomass Burning Aerosols.

NEALAN GERREBOS, F.K.A. Gregson, Julia Zaks, Allan K. Bertram, *University of British Columbia*

Liquid-liquid phase separation (LLPS) in atmospheric organic aerosols has wide ranging impacts, from affecting the lifetimes of pollutants to impacting cloud formation. It has previously been shown that coexistence of two or three liquid phases can occur in particles consisting of secondary and primary organic aerosols and inorganic salts, and is dependent on the constituent species having a wide range of oxygen-to-carbon ratios. However, little work has been done to investigate the prevalence of LLPS in biomass burning aerosols (BBA), a major class of organic aerosol. The composition of BBA, and thus the presence of LLPS, depends on the burning temperature, the type of fuel that combusts, and the aging processes that the aerosols have been subject to. Relative humidity also plays a crucial role. We used a temperature-controlled flow tube furnace to generate BBA from different burning or smoldering temperatures, and collected aerosols by impaction on glass slides to observe LLPS with a variety of microscopy techniques. We then compare the lab-generated samples to extracts of BBA collected from wildfires in British Columbia to assess how well lab conditions can approximate those in the real world.

5AC.5

Quantified Volatility Distributions from Monoterpene SOA.

DAVID BELL, Jun Zhang, Jens Top, Natasha Garner, Fabian Mahrt, Mihnea Surdu, André S. H. Prévôt, Imad El Haddad, *Paul Scherrer Institute*

The saturation vapour concentration (Log C*) of a molecule represents a key variable that governs the ability of molecules to nucleate new particles and partition into pre-existing aerosols. Thus, the saturation vapour concentration affects the chemical composition and the mass yields of ambient aerosol, ultimately affecting air pollution and climate. The determination of saturation vapour concentration is straightforward for small molecules, and those readily synthesized. In the atmosphere, the oxidation of volatile organic compounds creates a complex mixture of organic molecules in both the gas and condensed phase. Such mixtures or their individual molecules cannot be readily obtained as commercial standards, to determine their saturation vapour concentrations.

A thermal denuder coupled to a scanning mobility particle sizer (TD-SMPS) has been employed to determine the saturation vapour concentration of single component systems. However, the lack of chemical resolution prevents its applicability to determine the saturation vapour concentration of more complex organic mixtures such as secondary organic aerosol (SOA). Consequently, considerable uncertainties still exist regarding the saturation vapour concentration of ambient SOA components and hence the impact of SOA for air pollution and climate. To address this, we deployed an extractive electrospray ionization mass spectrometer (EESI-MS) coupled with a TD-SMPS (hence TD-SMPS+EESI) to provide molecular formula separation of complex mixtures together with their saturation vapour concentrations. We performed measurements on a complex mixture of known species (PEG-300) and then utilized SOA types derived from the ozonolysis of monoterpenes in an atmospheric simulation chamber.

Coupling this method with quantified measurements of grouped monomers, dimers, and higher order oligomers, we can provide a quantified volatility distribution for SOA derived from different monoterpenes. We will discuss the systematic differences in the volatility distribution of SOA from monoterpenes, as well as how they evolve during chamber experiments.

5AC.6

Simultaneously Characterizing the Volatility Distribution and Phase State of Laboratory-Generated and Ambient Aerosol Particles with a Vocus 2R Chemical Ionization Mass Spectrometer.

Sining Niu, Jordan Krechmer, Harald Stark, YUE ZHANG, *Texas A&M University*

Aerosols are ubiquitous in the atmosphere, and they play critical roles in both climate and human health. Recent studies have shown that the physicochemical properties of aerosols, including the volatility and phase state, have significant implications on their growth, gas-particle partitioning, chemical reactivity, and climate impacts. Nevertheless, obtaining the online volatility and phase state information of atmospheric particles has been challenging, limited our abilities to accurately predict their evolution and climate implications.

This study establishes a novel online method for the first time to obtain both the volatility distribution and phase state with the Vocus 2R Chemical Ionization Mass Spectrometer and Vocus Inlet for Aerosols (Vocus 2R/VIA). A calibration line linking thermal desorption temperature to known saturation mass concentration (C*) is first established using six types of pure organic aerosols, covering a range from 0.001 – 1000 µg m^{-3}. The volatility distribution of secondary organic aerosols (SOA) is determined by using multi-linear regression fitting on the desorption curve with calibration data.

The viscosity value, a parameter to characterize aerosol phase state, is subsequently quantified by combining the volatility distribution, a volatility-glass transition parameterization, and the Vogel-Tammann-Fulcher (VTF) equation at any given temperature and relative humidity (RH). This method is further validated using lab-generated α-pinene and β-caryophyllene SOA from ozonolysis reactions, with the derived viscosity values agreeing with previous literature findings.

This above method is applied during a mobile laboratory field campaign to determine the real-time volatility and viscosity of ambient aerosols. Combined with meteorological conditions (such as RH and temperature) and inorganic chemical composition from an high resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS), the phase state of complex ambient particles were determined. The results demonstrates that the phase state of the complex aerosols in Houston are mostly liquid or semi-solid. Such techniques provide a unique way to measure the phase state of the aerosol particles with high time resolution. The results can help further constraining the formation, reaction, and climate effects of aerosol particles.

5AC.7

Evaluation of Regional-Scale Model Parameters in the Prediction of Isoprene Epoxydiol (IEPOX)-Derived Secondary Organic Aerosols (SOA) Generated during Laboratory Chamber Experiments. ALEXANDRA NG, Yuzhi Chen, Jaime Green, Jason Surratt, Haofei Zhang, William Vizuete, *University of North Carolina at Chapel Hill*

Isoprene epoxydiol (IEPOX)-derived secondary organic aerosols (SOA) are formed in humid, low nitric oxide (NO) environments from the acid-controlled reactive uptake of gas-phase IEPOX to pre-existing sulfate aerosols. IEPOX SOA have been found to contribute up to 30% of organic aerosols in the Southeastern United States and Amazon rainforest. IEPOX SOA tracers consist primarily of 2-methyltetrols (2-MT) and 2-methyltetrol sulfates (2-MTS), which can subsequently form dimers and higher order oligomers. IEPOX SOA tracers can phase separate to form a viscous organic shell with an inorganic core. This core-shell morphology can inhibit reactive uptake of IEPOX and affects the acidity and kinetics of IEPOX SOA formation. Due to the importance of this SOA pathway, IEPOX SOA chemistry has been implemented in regional scale models with varying complexity, such as in the Community Multiscale Air Quality (CMAQ) Modeling System and Weather Research, and Forecasting model coupled with Chemistry (WRF-Chem). In this work, important parameters (reaction rate constants, Henry's law coefficient, thermodynamically modeled acidity) used by these modeling systems to predict IEPOX SOA formation and IEPOX reactive uptake were investigated in a box model to identify sensitivities to kinetics, diffusivity, and acidity changes. This evaluation included indoor chamber experiments conducted by collaborator, Yuzhi Chen, with environmental sensitivities to the IEPOX:Sulfate ratio at a fixed initial aerosol pH (i.e., 1.5). Base model parameter results were compared to an optimized model that could predict experimental measurements. CMAQ and WRF-Chem approaches were modified to include the latest state-of-the-science on IEPOX SOA formation kinetics, phase state parameters, and the inclusion of organic acidity. This work provides insights into the physiochemical properties and modeling parameters critical to formation of IEPOX SOA with chamber-based measurements.

5CC.1

First Results from Coastal Cloud Chemistry at Mt. Soledad during the Eastern Pacific Cloud Aerosol Precipitation Experiment (EPCAPE). LYNN RUSSELL, Abigail Williams, Jeramy Dedrick, Christian Pelayo, Nattamon (Jeep) Maneenoi, Sourita Saha, Sanghee Han, Elavarasi Ravichandran, Markus Petters, Catherine Banach, Veronica Berta, Suzanne E. Paulson, Rachel Chang, Laura-Helena Rivellini, Jonathan Abbatt, Alex K.Y. Lee, Jeremy Wentzell, Michael Wheeler, John Liggio, EPCAPE Science Team, *Scripps/UCSD*

Coastal cities provide the opportunity to characterize marine clouds and the substantial effects of manmade particles on cloud properties and processes. La Jolla lies to the north of San Diego, CA, but it is often about a day directly downwind of the major pollution sources located in the ports of Los Angeles and Long Beach. The large dynamic range of aerosol particle concentrations combined with the multi-hour to multi-day persistence of stratocumulus cloud layers makes the site ideal for investigating the seasonal changes in cloud and aerosol properties as well as quantifying the relationships between cloud and aerosol properties. The Eastern Pacific Cloud Aerosol Precipitation Experiment (EPCAPE) is taking advantage of the coastal location of La Jolla to characterize the extent, radiative properties, aerosol interactions, and precipitation characteristics of stratocumulus clouds in the Eastern Pacific across all four seasons at the Scripps Pier and the Mt. Soledad. In collaboration with the DOE Atmospheric Radiation Measurement (ARM) deployment of the first Atmospheric Measurement Facility (AMF1) cloud, aerosol, and precipitation instrumentation at the Scripps Pier in La Jolla from February 2023 to February 2024, our multi-institution, international collaboration is collecting physical and chemical measurements at Mt. Soledad (~250 m above and 3 km to the southeast of the Scripps pier) of aerosol particles, gases, and droplet residuals. Sampling from an isokinetic aerosol inlet in clear air and a counterflow virtual impactor in cloud provides characterization of the activated and aerosol phases associated with cloud chemical processing and microphysics. Measurements include cloud condensation nuclei (CCN) properties, chemical contributions to CCN, oxidation of components, and production of gas-phase species. Here we report some of the first results of aerosol-cloud interactions measured during the record-breaking precipitation events of 2023. The observations show size-resolved changes in the droplet residual distribution tracks the drop distribution, with some expected changes in chemical composition between aerosols and droplets. Comparison of aerosol size distribution during and after precipitation events provides an approach for quantifying wet scavenging. In addition, we report aerosol population types from the single-particle mode of the aerosol mass spectrometer (AMS) collected by event-based triggering for the characterization of the activated fraction.

5CC.2

pH-Dependence of Brown Carbon Optical Properties in Cloud Water. CHRISTOPHER HENNIGAN, Michael McKee, Vikram Pratap, Bryanna Boegner, Jasper Reno, Lucia Garcia, Madison McLaren, Sara Lance, *University of Maryland, Baltimore County*

The acidity (or pH) of atmospheric particles and clouds affects the optical properties of brown carbon (BrC) and rates of BrC loss through chemical reaction or photolysis. Given the wide variability of pH in the atmosphere (pH in particles and clouds ranges from -1 to 8), the optical properties of BrC and its bleaching behavior are expected to vary significantly, and the link between pH and BrC is a major uncertainty in attempts to constrain its climate forcing effects. In this work, we characterize the pH-dependence of BrC optical properties – including light absorption at 365 nm (Abs_{365}), mass absorption coefficient (MAC_{365}), and the absorption Ångström exponent (AAE) – in bulk cloud water sampled from the summit of Whiteface Mountain, NY. In all samples (n = 17), Abs_{365} and MAC_{365} increased linearly with increasing pH, highlighting the importance of reporting pH in studies of BrC in aqueous media. There was strong variability in the sensitivity of Abs_{365} to pH, with normalized slopes that ranged from 5.1% to 17.2% per pH unit. The normalized slope decreased strongly with increasing cloud water [K^+], suggesting that the non-biomass burning BrC has optical properties that are more sensitive to pH than BrC associated with biomass burning. AAE also showed a distinct pH-dependence, as it was relatively flat between pH 1.5 – 5, then decreased significantly above pH 5. The cloud water composition was used to inform thermodynamic predictions of aerosol pH upwind/downwind of Whiteface Mountain and the subsequent changes in BrC optical properties. Overall, these results show that, in addition to secondary BrC production, photobleaching, and the altitudinal distribution, the climate forcing of BrC is quite strongly affected by its pH-dependent absorption.

5CC.3

Aerosol Properties Observed during the CACTI Campaign in Argentina. JEROME FAST, Fan Mei, Jason Tomlinson, Mikhail Pekour, Beat Schmid, Alla Zelenyuk, Arthur J. Sedlacek, Maria Zawadowicz, Bin Zhao, Po-Lun Ma, Adam Varble, *Pacific Northwest National Laboratory*

The Cloud, Aerosol, and Complex Terrain Interactions (CACTI) field campaign was conducted over the Sierras de Cordoba range in north-central Argentina between October 2018 and April 2019 to better understand the role of atmospheric thermodynamics, topographic forcing, and aerosols on the lifecycle of convective clouds. The extreme storms in this region are some of the deepest, largest, and longest-lived on Earth. The extensive CACTI measurements thus provide an opportunity to better understand interactions between aerosols and convective cloud properties that are highly uncertain. As a first step, this study characterizes the spatial and temporal variations in aerosol number, mass, size, composition, compositional mixing state, and cloud condensation nuclei using both ground and airborne instrumentation. Aerosol properties were found to be strongly controlled by changing synoptic meteorological conditions. The northerly low-level jet along the eastern side of the Andes frequently transports biomass burning aerosols from the southern Amazon basin into Argentina. When the winds shift to the south, concentrations of accumulation mode aerosols decrease as concentrations of coarse dust particles originating from Patagonia increase. Accumulation mode aerosols on some days are highly correlated with carbon monoxide, suggesting the aerosols primarily originate from anthropogenic or biomass burning sources. This correlation is weak on other days, suggesting natural sources dominate. Ground and aircraft measurements are combined and analyzed to determine whether increases in surface ultrafine particle concentrations are due to downward entrainment from the lower free troposphere or local new particle formation events in the boundary layer. Since relatively few in situ aerosol measurements have been collected in the southern hemisphere, CACTI measurements provide an opportunity to evaluate global model predictions. Therefore, we also compare E3SM model predictions, with and without new treatments of nucleation and ultrafine particles, to aircraft and ground measurements to help explain the possible mechanisms responsible for aerosol nucleation.

5CC.4

Rapid Changes in the Particle Mixing State through Cloud Processing. LAURA FIERCE, Payton Beeler, Alla Zelenyuk, ManishKumar Shrivastava, Nahin Ferdousi, *Pacific Northwest National Laboratory*

Aerosol transformations during cloud processing play a critical role in the aerosol lifecycle, but these aerosol-cloud processes remain poorly understood. Aerosol particles are critical for cloud droplet formation, and their ability to form cloud droplets depends small-scale variability in aerosol properties that are not easily modeled or measured. After forming cloud droplets, particle characteristics are further modified through chemistry. Single-particle measurements from DOE's Holistic Interactions of Shallow Clouds, Aerosols, and Land-Ecosystems (HI-SCALE) campaign revealed large differences between cloud droplet residuals and aerosol particles at cloud base. These differences may result from preferential activation of one particle type over another, in-cloud chemistry, or a combination of the two. To disentangle the processes driving the evolution of the mixing state, we introduce the PArtiCle-based Aerosol-Cloud-chEmistry (PALACE) model, which tracks the evolution of individual particles as they evolve through cloud processing. Modeled particle populations were initialized using below-cloud aerosol observations from HI-SCALE, and model predictions were evaluated against observations of cloud droplet residuals. The observed changes in the particle mixing state are captured only when both preferential scavenging and aqueous chemistry are included in the model. This study represents an important step toward integrating particle-resolved modeling with single-particle measurements, while also advancing our process-level understanding of the aerosol lifecycle.

5CC.5

Strikingly Positive Contributions of New Particle Formation to Cloud Condensation Nuclei under Low Supersaturation in China Based on Improved Numerical Models. YANG GAO, Chupeng Zhang, Shangfei Hai, Yuhang Wang, Shaoqing Zhang, Lifang Sheng, Bin Zhao, Shuxiao Wang, Jingkun Jiang, Xin Huang, Xiaojing Shen, Junying Sun, Aura Lupascu, ManishKumar Shrivastava, Jerome Fast, Wenxuan Cheng, Xiuwen Guo, Ming Chu, Nan Ma, Juan Hong, Qiaoqiao Wang, Xiaohong Yao, Huiwang Gao, *Ocean University of China*

New particle formation (NPF) and subsequent particle growth are important sources of condensation nuclei (CN) and cloud condensation nuclei (CCN). While a number of observations have shown positive contributions of NPF to CCN at low supersaturation, simulation results, however, in general indicate negative NPF contributions. Using the observations in North China, we thoroughly evaluate the simulated number concentrations of CN and CCN using a NPF-explicit parameterization embedded in WRF-Chem model. By adjusting the process of gas-particle partitioning, including mass accommodation coefficient of sulfuric acid, the phase changes of primary organic aerosol emissions and the condensational amount of nitric acid, the concomitant improvement of the particle growth process yields a substantial reduction of overestimates of small particle number concentrations. Regarding CCN, SOA formed from the oxidation of semi-volatile and intermediate volatility organic vapors (SI-SOA) yield is an important contributor. Lowering the SI-SOA yield results in much improved simulations. On the basis of the bias-corrected model, we find substantial positive contributions of NPF to CCN at low supersaturation (~0.2%) over the broad areas of China, primarily due to the competing effects of increasing particle hygroscopicity surpassing that of particle size decrease. This study emphasizes that the potentially much larger NPF contributions to CCN on a regional and even global basis.

5CC.6

On Nucleation Pathways and Particle Size Distribution Evolutions in Stratospheric Aircraft Exhaust Plumes with H2SO4 Enhancement. FANGQUN YU, Gan Luo, Arshad Nair, Jason Herb, Alex Wong, *The State University of New York at Albany*

To respond to the ongoing climate crisis, the top priority is to rapidly reduce emissions of carbon dioxide and other greenhouse gases, which are the root drivers of global warming. Nevertheless, because of the challenges of cutting emissions at adequate rates and the long lifetime of greenhouse gases, it is necessary to understand the full range of options available for protecting the safety of human and natural systems. Stratospheric aerosol intervention (SAI) is proposed as a climate intervention to reduce global warming and climate change impacts. Introducing particles into the stratosphere could reflect sunlight and reduce warming, but there remain uncertainties about the roles of nucleation mechanisms, ions, impurities, and ambient conditions toward generating SAI particles optimally sized to reflect sunlight. Here, we use a kinetic ion-mediated and homogeneous nucleation model to study the formation of H_2SO_4 particles in aircraft exhaust plumes. We find that for the H_2SO_4 loading rate to produce particles of desired sizes, nucleation occurs in the nascent ($t < 0.01$ s), hot ($T = 360$–445 K), and dry (RH = 0.01–0.1%) plume and is predominantly unary. Nucleation on chemiions occurs first, followed by neutral nucleation which converts most of injected H_2SO_4 vapor to particles. Coagulation in the aging and diluting plume governs the subsequent evolution to a narrow ($\sigma_g = 1.3$) particle size distribution. Scavenging by exhaust soot is negligible but can matter for impurities or incomplete evaporation and background aerosols. This research highlights the need to consider aerosol microphysical and plume dilution processes to determine the size distribution and ultimate radiative properties of SAI particles.

5CC.7

Investigating the Spatio-Temporal Controls of Summertime Sea Breeze Circulation on the Atmospheric Aerosol Environment in the Houston Coastal Region. TAMANNA SUBBA, Michael Jensen, Ashish Singh, Rebecca Trojanowski, Dié Wang, Maria Zawadowicz, Chongai Kuang, *Brookhaven National Laboratory*

From October 1, 2021, to September 30, 2022, the DOE ARM TRacking Aerosol Convection Interactions ExpeRiment (TRACER) campaign provides a unique opportunity to study the aerosol processes that impact the climate in Houston, Texas, particularly in the urban and coastal environment where isolated convection systems and industrial and urban emissions are commonly observed. Additional aerosol measurements from June 1 to September 30, 2022, are gathered from an ancillary site in a more rural atmospheric environment and provide a strong contrast to the more urban-influenced aerosol measurements at the main site. In the TRACER environment, sea-breeze circulations (SBC), driven by the temperature differences between the land and water surfaces, play a crucial role in affecting local weather conditions in coastal regions by forming convective clouds and altering surface thermodynamics, leading to turbulence and mixing in the lower atmosphere. Consequently, SBC could have spatio-temporal control over the atmospheric aerosol environment, affecting their physical, chemical, and optical properties. A set of comprehensive observations were analyzed, collected during the summer months of 2022 from both the TRACER main and ancillary sites, including measurements of (1) aerosol number size distribution and concentration, (2) bulk aerosol chemical composition, and (3) meteorology. The data is used to characterize the atmospheric controls on aerosol. The WRF-Chem model simulations, constrained by these observations, were then performed to explore the spatio-temporal controls of meteorological phenomena such as SBC on the aerosol environment in the coastal region of Houston. This combined measurement and modeling analysis will provide valuable insights into the meteorological controls on the local to a regional aerosol environment in the coastal Houston region.

5DI.1

Identification of Neighbourhood Hotspots via the Cumulative Hazard Index: Results from a Community-Partnered Low-cost Sensor Network Deployment.

Sakshi Jain, Rivkah Gardner-Frolick, Nika Martinussen, Dan Jackson, Amanda Giang, NAOMI ZIMMERMAN, *University of British Columbia*

Historically marginalized communities often experience environmental injustice due to disproportionately high air pollution concentrations relative to other communities. The Strathcona neighborhood in Vancouver is particularly vulnerable to environmental injustice due to its close proximity to the Port of Vancouver, major roads and railways, and a high proportion of Indigenous and low-income households. Furthermore, local sources of air pollutants (individual roadways, individual industrial facilities) can contribute to small-scale variations within communities.

The aim of this study was to assess hyperlocal air quality patterns (intra-neighborhood variability) and compare them to average Vancouver concentrations (inter-neighborhood variability) to recognize the disparities in risks and burdens faced by the Strathcona community. Between May and August 2022, 11 low-cost sensors (LCS) were deployed in household backyards within the neighborhood to collect $PM_{2.5}$, NO_2, and O_3 concentrations. The collected 15-minute concentrations were down-averaged to daily concentrations and compared to greater Vancouver region concentrations to quantify the inequities faced by the community. Concentrations were also estimated at every 25m grid within the neighborhood using ordinary kriging. Using population information from Census data, cumulative hazard indices (CHIs) were computed for every dissemination block.

We found that although $PM_{2.5}$ concentrations in the neighbourhood were lower than Vancouver averages, daily NO2 concentrations and summer ozone concentrations consistently exceeded the Vancouver averages; comparing sensor data with average city concentrations can assist the community in their advocacy efforts. Although CHIs varied daily, we found that CHIs were consistently higher in areas with high commercial activity. As such, estimating CHI for dissemination blocks was useful in identifying hotspots and areas of concern within the neighborhood. The kriging model was more easily implemented than traditional land use regression models, and may be useful community-deployable tools for spatial air pollutant modelling.

5DI.2

Spatial Modeling of Ambient PM2.5 and Ozone Exposure in Western Massachusetts Using a Low-Cost Air Quality Monitoring Sensor Network.

DONG GAO, Jiarong Qi, Alexander De Jesus, Kerry Kelly, Sarita Hudson, Krystal Godri Pollitt, *Yale University*

The impact of ambient fine particulate matter ($PM_{2.5}$) and ozone exposure on public health is well recognized, particularly in areas with high asthma prevalence. The Pioneer Valley region in Western Massachusetts, reported to be one of the most challenging places to live with asthma in the US, faces limitations in assessing air pollutant exposure due to the sparse distribution of regulatory air quality monitoring stations. To address this gap and evaluate the spatiotemporal variability of $PM_{2.5}$ and ozone exposure in fine scale, we leveraged emerging low-cost sensors (TELLUS AirU and PurpleAir) and engaged community residents to develop a community-based air quality monitoring network across environmental justice communities, through a partnership between local community groups, city officials, non-for-profit organizations, health care facilities, academic researchers, and residents in the cities of Springfield, Chicopee, and Holyoke. Eighty sensors were strategically deployed across the region to capture spatial variations in $PM_{2.5}$ concentrations, including twenty metal oxide sensors for ozone monitoring. Prior to deployment, the sensors were calibrated against reference instruments to derive correction factors for each sensor. A correlation was identified between sensors, with coefficients of determination R^2 of 0.98~0.99 for $PM_{2.5}$ measurements and greater than 0.85 for reducing and oxidizing gases measurements, demonstrating similar level of accuracy and reliability of sensors in real environmental scenarios. For post-deployment calibration, we derived long-term $PM_{2.5}$ and ozone calibration models with over one-year data, using multiple linear regression and the random forest algorithm, respectively. These models were applied to the sensors throughout the study region to provide pollutant estimates at fine spatiotemporal scales. Integrating low-cost sensors into citizen-science based air monitoring program has promising applications to resolve monitoring disparity and capture hotspots to inform the community of the potential burden on health.

5DI.3

Community-Driven Air Justice: Insights from Distributed Air Sensing and Community Partnership in Boston, MA. Scott Hersey, FRANCESCA MAJLUF, Eben Cross, Vedaant Kuchhal, Khue Pham, Sanju Jatti, *Franklin W. Olin College of Engineering*

In 2020, the Air Partners group at Olin College of Engineering established a new partnership with Alternatives for Community and the Environment (ACE), a decades-old, Black-led environmental justice (EJ) advocacy organization in the EJ community of Roxbury in Boston, MA. The goal of this partnership was to: 1) establish a community-driven air monitoring network, 2) pilot and evaluate the use of HEPA air purifiers to strategically reduce exposure for high-priority residents, and 3) leverage data and insights from monitoring and HEPA pilots to support ACE's advocacy, base-building, and legislative goals. In this talk we will describe our approach to partnership and stakeholder engagement to identify project priorities and collaboratively plan the project; our process of collaborative project execution as a means of equipping community partners; and insights about the signature and relative importance of various pollutant sources in Roxbury based on the first year of air monitoring across a network of 18 particle and gas sensors. We will also share examples of how insights are packaged to support community goals, as well as case studies describing how partners are leveraging data for action.

5DI.4

Environmental Justice Assessment of Formaldehyde Exposure during a Photochemical Pollution Episode in Southeast Texas. YITING LI, Yusheng Zhao, Michael Kleeman, *University of California, Davis*

Formaldehyde (HCHO) is a ubiquitous organic compound found in urban air across the globe, with concentrations that are typically an order of magnitude higher than concentrations of more complex aldehydes. Many epidemiology studies have demonstrated a correlation between HCHO exposure and cancer risk. HCHO was ranked as the greatest cancer driver of risk across the United States by the US Environmental Protection Agency in the year 2018. Although indoor sources of HCHO can be large, recent studies show that outdoor HCHO concentrations contribute significantly to total HCHO population exposure. HCHO exposure represents a continuing public health risk that must be understood before it can be efficiently mitigated.

Here we calculate primary and secondary HCHO exposures for different race/ethnicity groups living in southeast Texas during a regional summertime air pollution event using a chemical transport model (CTM). Exposure calculations are performed for sixteen different formaldehyde sources using the tagging options available in the CTM. Exposure disparities by race/ethnicity are calculated, and recommendations to reduce these disparities are formulated. The results show that biogenic emissions reacted to form secondary HCHO that accounted for 44% of the total population-weighted exposure across the study domain. Primary refinery and industrial emissions were the largest anthropogenic sources of HCHO exposure in southeast Texas. Mobile sources accounted for 3.5% of the total HCHO population exposure. African American residents were exposed to HCHO concentrations +20% higher than average, mostly due to primary refinery emissions. Asian residents were exposed to HCHO concentrations that were 5% higher than average due to HCHO associated with on-road vehicles, off-road diesel vehicles, and other sources. White residents were exposed to lower-than-average HCHO concentrations because their homes were located further from primary HCHO emissions sources. Disparities in cancer risk that are proportional to HCHO exposure could be reduced by controlling primary HCHO emissions from refineries, or by rezoning larger areas around these facilities for non-residential use.

5DI.5

Physico-Chemical Characterization of Dust: A Comprehensive Study of Particulate Matter (PM) in the Environmental Justice (EJ) Community of Eastern Coachella Valley (ECV).

CHRISTOPHER LIM, Mohammad Sowlat, Julia Montoya-Aguilera, Steven Boddeker, Freyja Berg Lopez, Laura Saucedo, Cynthia Berg, Angela Haar, Stephen Dutz, James Rothchild, Eric Holden, Sina Hasheminassab, Matic Ivančič, Martin Rigler, Payam Pakbin, Andrea Polidori, 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 California Air Resources Board (CARB) provided the opportunity for the South Coast AQMD to further address air quality issues in Environmental Justice (EJ) communities that are disproportionately impacted by air pollution. Eastern Coachella Valley (ECV) is an AB 617-designated EJ community in the Salton Sea Air Basin that is impacted by several sources of particulate matter (PM), including desert and Salton Sea playa dust, agricultural burning, and motor vehicles. As part of efforts to better characterize emission sources in ECV, South Coast AQMD developed and implemented a comprehensive study from January 2022 through May 2023 to better characterize PM/dust and identify its sources and origins in the area. This campaign relied on a combination of time-integrated PM sampling techniques and time-resolved measurements by continuous monitors to fully characterize physical characteristics (size, shape, and morphology) and chemical composition (i.e., carbonaceous compounds, trace metals, and ions) of the PM/dust in this area. This presentation will give an overview of the study design as well as the methods/instruments used for time-integrated and time-resolved characterization of dust/PM, and provides preliminary results from this comprehensive campaign. The information gathered in this study will help distinguish different sources of dust/PM and their relative contribution to air quality in ECV. These monitoring efforts help support effective actions to reduce emissions of and exposure to dust in ECV and will provide valuable data to inform future actions by different stakeholders (community, researchers, governmental agencies).

5DI.6

Comparing Outdoor, Indoor, and Personal PM Levels in an Environmental Justice Community in California's Central Valley.

JESSICA TRYNER, Grace Kuiper, Sherry WeMott, Bonnie Young, Luis Hernandez Ramirez, John Volckens, Sheryl Magzamen, *Colorado State University*

People living in the United States (U.S.) typically spend >90% of their time indoors, mostly in their homes. As a result, both outdoor and indoor pollution sources contribute to personal exposure to particulate matter (PM); however, most data on PM pollution are collected for outdoor ambient conditions. Furthermore, factors that can enhance or mitigate exposure to pollutants outside and inside a person's home are linked to environmental justice (EJ) issues associated with the history of racially- and ethnically-discriminatory land use and housing policies in the U.S. In this study, we measured 24-h in-home concentrations of and personal exposures to $PM_{2.5}$ and PM_{10} for 47 adults living in 27 households within a designated EJ community in California's Central Valley. We also surveyed participants about characteristics of their home as well as possible sources of pollution outside and inside the home. Personal exposures to $PM_{2.5}$ tended to exceed outdoor concentrations (median personal = 15.3 $\mu g\ m^{-3}$; median outdoor = 8.9 $\mu g\ m^{-3}$; median personal − outdoor difference = 11.7 $\mu g\ m^{-3}$), and personal exposures to PM_{10} tended to be lower than outdoor concentrations (median personal = 52.4 $\mu g\ m^{-3}$; median outdoor = 80.5 $\mu g\ m^{-3}$; median personal − outdoor difference = -35.1 $\mu g\ m^{-3}$). Personal exposures were only weakly correlated with outdoor concentrations measured by regulatory and community monitors (Spearman correlation = 0.27 for $PM_{2.5}$ and -0.19 for PM_{10}), but personal exposures were more strongly correlated with in-home concentrations (Spearman correlation = 0.61 for $PM_{2.5}$ and 0.59 for PM_{10}). Prior studies in other U.S. communities have reported median personal and outdoor $PM_{2.5}$ levels both lower and higher than those measured here. We will discuss variables associated with personal PM exposure as well as the need for more widespread indoor and personal measurements.

5DI.7

Autonomous Network of Low-Cost PM2.5 and Ozone Sensors to Study Spatial Distribution and Exposure in Underserved Agricultural Communities in California. Akshay Kumar, Daniel Polinski, Casey Quinn, Sheryl Magzamen, Nayamin Martinez, Genevieve Amsalem, SHANTANU JATHAR, *Colorado State University*

Fine particulate matter ($PM_{2.5}$) and ozone (O_3) are criteria pollutants that are rarely measured in rural and remote environments, even in regions of the Global North. Hence, the spatial distribution and exposure to $PM_{2.5}$ and O_3 in these regions, many of which are populated by small, underserved, and disadvantaged communities, remains poorly understood. In this work, we will build, calibrate, and deploy a network of 12 autonomous, low-cost, and solar-powered air quality monitoring units (VOZbox) in the San Joaquin Valley (SJV) of California . Each VOZbox includes the following components: (i) two light scattering $PM_{2.5}$ sensors (Plantower PMS5003T and Sensirion SPS30); (ii) a heated metal oxide O_3 sensor (Aeroqual SM50), mounted inside a custom radiation shield; (iii) a global positioning system (GPS) sensor and an environmental sensor to measure temperature and relative humidity; (iv) a power system that consisted of a 30 W solar panel, 108 Wh lithium-ion battery, and charge controller; and (v) a Particle Boron microcontroller to acquire, process, and transmit data to the Cloud. All 12 VOZboxes will initially be co-located with a reference monitor in Fresno, California for about a week to develop unit-specific calibrations. These will then be deployed in 11 unique locations in Fresno, Kings, and Tulare Counties in SJV, which are host to many agricultural communities. Results from this study will be available in near real-time over the Cloud. $PM_{2.5}$ and O_3 data from this network deployment will be used to study (i) diel and spatial patterns in $PM_{2.5}$ and O_3 and (ii) exposure to these pollutants in these sparsely populated regions relative to the urban corridor between Fresno and Bakersfield, California.

5HA.1

Route of Pulmonary Administration of Aerosols and the Size of Aerosols Significantly Affects Particle Deposition and Cellular Recruitment. RYAN W. DROVER, Keziyah Yisrael, Malia L. Shapiro, Martha Anguiano, Nala Kachour, Qi Li, Emily Tran, David R. Cocker III, David D. Lo, *University of California, Riverside*

Lung exposures to dusts, pollutants, and other aerosol particulates are known to be associated with a number of pulmonary diseases, including asthma and Chronic Obstructive Pulmonary Diseases. These health impacts are related to the ability of aerosol components to induce lung tissue inflammation, which promotes tissue remodeling, including fibrosis, tissue degradation, and smooth muscle proliferation, so the distribution of these effects can have a significant impact on lung physiologic function. To study the impact of distribution of inhaled particulates on lung pathogenesis, we compared the effect of different modes of aerosol delivery. Intranasal versus aerosol delivery of fluorescent microspheres showed strikingly different patterns of particle deposition; intranasal delivery provided focused deposition concentrated on larger airways, while aerosol delivery showed uniform deposition throughout the lung parenchyma. Since inflammatory cell impacts will also depend on the recruitment and behavior of the recruited cells, we then studied the responses to administration of endotoxin (bacterial Lipopolysaccharide, or LPS). Similar to the microsphere results, patterns of recruited neutrophil inflammatory responses matched the delivery method; that is, despite the migratory potential of active neutrophils, inflammatory histopathology patterns were either focused on large airways (intranasal administration) or diffusely throughout the parenchyma (aerosol). These results help establish validated models to study the impacts of aerosol exposures, as different patterns of inflammation and tissue remodeling will have distinct impacts on aspects of lung physiology.

5HA.2

CFPD-PK Modeling of Inhaled Medical Cannabis: The Role of Puffing Waveform and Holding Time in Delivered Doses.

TED SPERRY, Yu Feng, Chen Song, Zhiqiang Shi, Qi Li, *Oklahoma State University*

Medical cannabis is increasingly used as an alternative therapy for various conditions, including chronic pain, multiple sclerosis, epilepsy, and cancer-related symptoms. However, it is crucial to ensure that patients receive the intended dose of tetrahydrocannabinol (THC) from inhaled cannabis so that the dosing regimen is safe and effective. This requires a comprehensive understanding of the factors that influence the pharmacokinetics (PKs) of THC in the respiratory system. To address this need, this study employed a hybrid computational fluid-particle dynamics (CFPD) and pharmacokinetics (PK) model to evaluate factors that influence delivered doses of THC to the human respiratory system and the resultant THC-plasma concentration-time profile. Specifically, this study compared multiple puff waveforms for inhale-hold-exhale (IHE) with puff volumes from 55 to 82 mL, considering step function velocities, sinusoidal puffs, as well as a measured puff profile. THC deposition in the airways was recorded during all phases for each case using either 452,849 particles per second for the 1.2 µm monodisperse cases or 399,866 per second for the polydisperse cases, with the mass median aerodynamic diameter (MMAD) of 1.2 µm. Regional deposition data is predicted using CFPD for four airway regions, then scaled by region-specific bioavailability factors. The deposited mass in airway regions represents the initial mass entering a 3-compartment PK model. Simulation results showed that puff volume, duration, and holding time significantly influence the delivered dose of THC in the respiratory system and the PK profile in plasma. Specifically, the deposition fractions for the 55 mL and 82 mL step-function cases are only 53% and 61% compared to the sinusoidal cases of the same inhalation volumes. Increased inhalation volume from 55 to 82 mL for sinusoidal IHE cases increased deposition by 13.24%. This study shows that the differences between deposited doses can vary by as much as 245%, while predicted peak plasma concentrations and area under the curve (AUC) vary by 126% for these conditions. Differences between deposition fraction and dosage are due to the limited bioavailability of the particles deposited. In conclusion, this study highlights the importance of accurately predicting the delivered dose of inhaled THC and optimizing dosing regimens for medical cannabis use. Furthermore, CFPD-PK simulations need to use realistic particle size distributions to accurately predict the delivered dose of inhaled THC, emphasizing the need for continued research in this area.

5HA.3

Introducing the Air Pollution Exposure in Child Care Settings (APECCS) Study: Measuring Indoor/Outdoor Air Quality at Child Care Centers and Residential Environments in the Atlanta Metropolitan Area.

ROBY GREENWALD, Yu Jung Lin, Donghai Liang, Christina H. Fuller, *Georgia State University*

Background: The pathogenesis of chronic diseases related to inhalation exposures occurs in early-life; however, public health efforts to reduce this disease-burden are complicated by two research difficulties: valid assessment of environmental exposure at young ages and challenges in identifying early childhood indicators of disease. To address these concerns, the ongoing Air Pollution Exposure in Child Care Settings (APECCS) study prospectively measures air pollution exposure in children ages 3-4 years and non-invasively explores biological mechanisms of response using salivary metabolomics.

Methods: We conducted 5-week sampling campaigns at child care centers representing Atlanta-region air quality: a “distant” site not near a major highway and a “near-road” site adjacent to a 14-lane interstate as well as freight rail, transit, and large parking structures. We used stationary and handheld devices to measure $PM_{2.5}$, particle number concentration, and black carbon (BC). A rotating sub-panel of participants performed residential and transportation environment measurements for 1-week periods using microsensors. We additionally collected weekly indoor and outdoor filter samples for gravimetric and elemental analysis.

Results: All measures of particle concentration are higher at the near-road site than the distant site. Indoor BC at the near-road site is higher on average than outdoor BC at the distant site. $PM_{2.5}$ did not exhibit pronounced diurnality at either site. Near-road BC reflected the diurnal pattern of traffic volume punctuated by passing locomotives. High levels of at-home $PM_{2.5}$ and BC were observed during meal preparation.

Conclusion: BC concentrations are influenced by nearby motor vehicle emissions. Other combustion sources such as heavy-rail locomotives were observed to have significant impact. The indoor and outdoor values of all particle measures were highly-correlated, indicating infiltration of ambient PM to indoor spaces with a contribution from indoors sources such as cooking activities. $PM_{2.5}$ levels were consistent with region-wide changes in air quality influenced by meteorology.

5HA.4

Different Languages Using Caused Diversity in Exhaled Aerosol Emission. XINYUE LI, Maosheng Yao, *Peking University*

The COVID-9 pandemic has caused a significant disruption to the society, presenting a public health disaster. Among many transmission routes, aerosol transmission, as one of the key routes for respiratory infections, has attracted great attention during the pandemic. The aerosol transmission route is featured being long range and difficult to detect. Human respiratory activities such as breathing and talking will produce and discharge a large amount of exhaled aerosols that may contain pathogens into the ambient air. However, emission characteristics data of exhaled aerosols are scare, including those regarding the use of different languages. In addressing the problems mentioned above, this study investigated the size-resolved exhaled aerosol particle emission characteristics by employing eight commonly used languages in expressing the same contents. The results showed that the number concentration of exhaled aerosol during conversation was mainly concentrated in range of 0.01-0.5 µm, and the peak level was 500-9000 particles/L across the size range of 0.01-0.1 µm. The total emission rates of Korean and Japanese speaking were significantly higher than those from other six languages. The exhaled aerosol emission rates were affected by language type, sound frequency distribution, gender, and body mass index. The exhaled aerosol emission rate of men was found slightly higher than that from women, and there was a positive correlation between male BMI and exhaled aerosol emission rate, while female BMI showed an inverted "U" distribution for exhaled aerosol emission rates.

5HA.5

The Clearance of Little Cigar Smoke Particles in the Lower Respiratory Tracts of Sprague Dawley Rats. Anthony S. Wexler, KAISEN LIN, *University of California, Davis*

Little cigars are harmful tobacco products that have gained popularity among adolescents. In our previous study, we investigated the deposition patterns of little cigar smoke in the lower respiratory tracts of Sprague Dawley rats. Particle clearance after exposure is an essential factor influencing the actual particle uptake by recipients, which significantly impacts disease development. Differences in particle sizes and properties result in considerable variations in clearance rates within recipients' respiratory tracts. Consequently, predicting the clearance rate of little cigar particles in respiratory tracts is challenging, warranting experimentation with animal models. Our previous study indicated slow clearance of little cigar smoke particles in the lower respiratory tracts of Sprague Dawley rats, which was much slower than that reported in the literature. Additionally, a lobe-dependent deposition pattern was observed. Specifically, particles were more likely to deposit in the left and right caudal lobes than in other lung regions. We hypothesize that particle clearance kinetics may also vary among different lobes.

In this study, we exposed 12-week-old female Sprague Dawley rats to little cigar smoke for 2 hours per day over two days. Rats were sacrificed on Day 0, 1, 7, and 21 post-exposure, and their lungs were separated to collect individual lobes. Lung tissues were acid-digested and subsequently analyzed via ICP-MS. Chromium (Cr) levels, serving as a tracer of smoke particles, were quantified in samples. Lobe-specific particle clearance rates were calculated based on the changes in Cr levels over time. This study's results will provide essential information on the clearance rate of little cigar smoke particles after inhalation and deposition in rats' lower respiratory tracts. Animal study results will be compared with those predicted by the MPPD model.

5HA.6

Short-term Neurological Impact of Cooking UFPs. Motahareh Naseri, Fatemeh Amouei Torkmahalleh, Seyedeh Fatemeh Seyedebrahimi, Seyedeh Ayeh Esmaeilitaleshi, Atousa Amouei Torkmahalleh, Mohammad Hossein Forouzi, Sahar Sadeghi, Mojtaba Jouzizadeh, Milad Malekitabrizi, Dhawal Shah, MEHDI AMOUEI TORKMAHALLEH, *University of Illinois at Chicago*

Indoor sources can produce particles that have the potential to penetrate and accumulate within human organs. Since many individuals spend a substantial amount of their time indoors, it is imperative to investigate the impact of indoor particulate matter on human health. Research on indoor sources has shown that cooking activities primarily contribute to the presence of particulate matter indoors. Emerging epidemiologic evidence suggests an association between exposure to UFPs and malignant brain cancer. Some recent clinical studies also showed the short-term exposure to the diesel particles impairs functional brain connectivity and brain wave pattern. Cooking emits a copious number of UFPs containing trace elements with different morphology. Clinical studies regarding the effects of cooking particles on the human brain are limited. This study aims to explore the short-term effects of particles from gas stove cooking on the human brain during and up to 24 hours after exposure. An expert biostatistician designed the study under A two-group, randomized controlled crossover trial. At least thirty healthy individuals in the age of 25-70 were recruited as human subjects. The study was conducted over two consecutive days inside a residential unit where controlled conditions could be maintained. The first day was a control, and the second day was a cooking day. The brain EEG was measured using an electroencephalograph (EEG) device. The cooking was conducted at 9:30 am on the second day for 20 minutes. The results showed that the greatest changes to the brain happened in the frontal lobe 30 and 60 minutes after cooking. The second change was observed eight and 10 hours after cooking in all brain lobes. After 24 hours, all brain wave bands return to their baseline state. Alpha band significantly increased exactly after cooking and two hours after cooking. Beta and theta bands showed a decreasing trend. However, the delta showed an increasing trend. To complement our brain study, secondary outcomes such as blood pressure, lung fractional exhaled nitrogen oxide (FeNO), blood oxygen, blood biomarkers and peak flow have been conducted. The results will be presented during the 2023 AAAR conference.

5HA.7

A Whole-Body Ultra-Fine Aerosol Exposure Chamber for Dynamic Detection of Alzheimer's Disease Biomarkers in Mice. JOSEPH V. PUTHUSSERY, August Li, Carla M. Yuede, John Cirrito, Rajan K. Chakrabarty, *Washington University in St.Louis*

A growing body of epidemiological studies indicates ambient particulate matter (PM) as a potential neurotoxin directly linked with the onset of Alzheimer's disease (AD). Researchers hypothesize that the chemical components present in PM, such as transition metals and carbonaceous aerosols if exposed to the brain, can induce chronic inflammation and produce reactive oxygen species that can damage the blood-brain barrier, and increase the production of amyloid-beta (Aβ; a biomarker of AD) peptides. While there is compelling evidence of a plausible association between air pollution exposure and AD, the exact mechanism of PM-induced neurotoxicity and AD remains largely unknown. While past AD mice model studies have investigated long-term exposure to air pollution, monitoring the dynamic changes in mice brain activity during acute PM exposure has remained a technological challenge.

Here, using state-of-the-art *in situ* measurement techniques, we designed and developed a whole-body mice exposure chamber coupled to a microdialysis (MD)-based real-time brain interstitial fluid (ISF) Aβ peptide measurement unit. The chamber can uniquely facilitate the investigation of acute (few hours) air pollution exposure in the formation of Aβ plaques in mouse brains. It consists of a custom-designed ~160-liter acrylic enclosure connected to a test pollutant generator at user-defined concentrations. The chamber holds two mice simultaneously inside specially designed individual RaTurn cages (BASi) that permit freedom of movement and ad-lib food/water while ISF is being sampled. Microdialysis probes are surgically implanted in the mouse's hippocampus, and the MD unit measures the Aβ peptide proteins within the brain interstitial fluid in freely moving awake mice every 60 minutes for 3-5 days. The temperature, relative humidity, particle size distribution, and particle number concentrations inside the chamber are monitored using real-time sensors. Chamber characterization using aerosolized monodisperse polystyrene latex beads shows the chamber is well-constrained and provides a uniformly mixed aerosol exposure environment for the test animals. Efforts are underway to test the mice's response when exposed to different nano-size environmental pollutants. Preliminary results based on exposure to real-world relevant air pollutants such as copper, iron, and biomass-burning aerosols will be presented.

5SC.1

The Trials and Tribulations of Scanning Electrical Mobility Measurements. FRED BRECHTEL, Andy Corless, Xerxes Lopez-Yglesias, *Brechtel Mfg. Inc.*

Rapid voltage scanning in the differential mobility analyzer (DMA) in scanning electrical mobility sizers (SEMS) radically reduced the time required to measure number size distributions. Although the method has become ubiquitous, there is still confusion regarding various important parameters, including: detector time response, upstream impactor cut size, charger, plumbing delay time, appropriate scan times, relative humidity, and optimizing operating parameters for maximum data quality.

For example, the minimum scan time (t_scan) is determined by the ratio of the mean gas residence time in the DMA and the characteristic time for the voltage ramp (=t_scan/ln[HV_max/HV_min]). Here, the DMA sheath flow rate, DMA dimensions, and the voltage scan range each play a role. The ratio should be smaller than about 0.2 to ensure the voltage ramp has sufficient time to act on particles within the DMA. Another practical limitation of very short scan times is poor counting statistics if insufficient particles are counted in each size bin.

The plumbing delay time is the travel time of a particle from the entrance slit of the DMA to the detection point of the detector. It depends on the DMA dimensions, sheath and sample flow rates, interconnect tubing volume between DMA and detector, and the transport time within the detector. Given how many factors determine the plumbing delay time, it’s no wonder confusion surrounds it. The best determination of the plumbing delay time is where the up and down-voltage scans of PSLs match.

To demonstrate the impact of the factors listed above, a miniature SEMS (Brechtel Model 9404) will purposely be operated with both correct and incorrect values to demonstrate the impact on the measured ambient size distribution.

5SC.2

Insights on Indoor New Particle Formation Using the PSMPS – A Mobility Particle Size Spectrometer Capable of Measuring Particles in the Size Range from 1.1 to 55 nm. GERHARD STEINER, Satya Patra, Jinglin Jiang, Connor Keech, Joonas Vanhanen, Aki Pajunoja, Nusrat Jung, Brandon E. Boor, *Grimm Aerosol Technik Ainring*

New particle formation (NPF) is widely known to be an important source of atmospheric particles (Kulmala et al. 2013) and contributes up to 50% to global cloud condensation nuclei (CCN) levels (Spracklen et al. 2008, Merikanto et al. 2009). NPF can also be a significant indoor source of ultrafine particles in buildings, which can lead to high inhaled deposited dose rates throughout the human respiratory system (Jiang et al. 2021, Rosales et al. 2022), thereby having a strong impact on human health. In order to understand the basic mechanisms of NPF and to calculate formation rates and size-resolved growth rates of freshly formed particles in indoor and outdoor atmospheres, it is crucial to measure aerosol number size distributions starting from the sub-3 nm size range.

In this collaborative presentation, we will share insights recent field measurements of indoor NPF events triggered by monoterpene ozonolysis during household activities. Given that people spend most of their time indoors and that monoterpene-based products are widely used, research is needed to determine the prevalence and characteristics of indoor NPF events during normal household activities in residential buildings – contribution from Purdue University.

The technical focus will lie on how to calibrate and how to utilize the newly developed tool, the Particle Size Magnifier – Scanning Mobility Particle Sizer (PSMPS). The PSMPS combines a short differential mobility analyzer (S-DMA), a diethylene glycol-based particle size magnifier (PSM), and a butanol-based condensation particle counter (CPC) – contribution from Grimm Aerosol Technik, Durag Inc., and Airmodus Ltd.

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5SS.1

Integration of Ground Measurement Networks, Numerical Models, and Satellite Data in the Characterization of PM2.5 Levels in the US. YANG LIU, *Emory University, Atlanta, GA*

Over the past two decades, satellite aerosol remote sensing data products have seen applications beyond their original design parameters and made great advancement in generating a wide range of societal benefits including ambient PM2.5 monitoring. However, satellite data often suffer from substantial missingness due to cloud cover or unfavorable retrieval conditions. Meanwhile, the paradigm of ground air quality monitoring is shifting with the citizen science movement where many individuals voluntarily collect air quality data through low-cost air quality sensors. However, using this emerging technology to improve PM2.5 pollution mapping still deserves careful planning given the greater measurement errors of low cost sensors. Chemical transport models (CTMs) such as the Community Multiscale Air Quality (CMAQ) Model can simulate PM2.5 with full coverage in space and time, greatly expanding the study population of air pollution health effect studies to cover both urban and rural populations. However, uncalibrated CTM simulations frequently suffer from substantial prediction errors caused by imperfect characterization of atmospheric chemistry, inaccurate emission inventory and rapidly changing local meteorology. This presentation provides a framework to take advantage of the strengths of the individual techniques towards high-quality and full-coverage PM2.5 mapping.

5SS.2

Fusing Surface Monitors, Satellites and Forecasts for Near-real-time Air Quality. BARRON HENDERSON, Pawan Gupta, Shobha Kondragunta, Phil Dickerson, Alqamah Sayeed, Hai Zhang, *EPA*

This talk will focus on bringing many data sources together to make the best air quality field possible. It is well known that surface monitors represent the best estimate of what is happening near the monitors, but that monitors are spatially and temporally sparse compared to many data sources. Low-cost sensors, satellites and forecast models are provide better spatial or temporal coverage, but are well-known to have biases. Models and surface monitors have long been “fused” using techniques like natural neighbor/voronoi adjustments. Low-cost Sensors have been calibrated to monitors and included in such fusions. Satellites have increasingly been used with surface observations and statistical models to create surface PM25. This talk will focus on a method and evaluation of a fusion of that includes all these datasets.

5SS.3

Assessment of PM2.5 Air Pollutant Health Damages with the REACH Reduced-Complexity Model. MEDINAT AKINDELE, Peter Adams, Nicholas Muller, Rebecca Garland, *Carnegie Mellon University*

The US has made strides in improving air quality since the enactment of the 1970 Clean Air Act, while air pollution has worsened in other countries over the same period. Evaluating the benefits of air pollution strategies requires models to estimate pollutant concentrations. The models typically used in the US for regulatory purposes are chemical transport models (CTMs): they simulate atmospheric and physical processes to predict ambient $PM_{2.5}$ concentrations. Although they are the gold standard for air quality modeling, they necessitate high computational costs and technical expertise. Therefore, they can only assess a limited number of policy scenarios, and many countries lack the technical capacity to use CTMs for policy evaluations. These limitations motivated the development of reduced-complexity models (RCMs), which are faster than CTMs and can assess many policy scenarios. However, most RCMs are hard coded to the US. Thus, we introduce the Rapid Estimation of Air Concentrations for Health (REACH) Gaussian plume model with chemistry. It is location-agnostic, allowing user-specified meteorology and emissions for any region. Here, we show results for the REACH model applied to the US to estimate county-level ambient $PM_{2.5}$ concentrations and health damages (premature mortalities per tonne of $PM_{2.5}$ or precursor emitted). Like CTMs, REACH-US reproduces $PM_{2.5}$ concentrations against standard monitors better in the eastern US ($R^2 = 0.39$) compared to the West. The estimated national-average health damages associated with $PM_{2.5}$ exposure resulting from ground-level emissions of $PM_{2.5}$, SO_2, NO_X, NH_3, and VOCs are 110, 106, 15, 33, and 17 $/ktonne, respectively. The health damage evaluations against other US RCMs (AP2, EASIUR, and InMAP) for ground-level $PM_{2.5}$ resulted in an R^2 correlation of 0.71-0.72. REACH can be expanded to other regions, and sample results from Southern Africa are presented to highlight its potential use in data-scarce areas.

5SS.4

Assessing PM2.5 Oxidative Potential in Fairbanks, Alaska Winter. YUHAN YANG, Peter F. DeCarlo, Ellis Robinson, Magesh K. Mohan, Jingqiu Mao, James Campbell, Rodney J. Weber, *Georgia Institute of Technology*

We investigated the oxidative potential (OP) of fine particulate matter ($PM_{2.5}$) in Fairbanks, Alaska, during winter and compared it to winter Atlanta and Los Angeles (LA). Approximately 40 23.5-hr filter samples were collected during the 2022 winter heating season and analyzed for OP via the dithiothreitol (DTT) and OH-generation in synthetic lung fluid assays. Utilizing measured chemical species, multivariate linear regression identified transition metals, especially Fe and Cu, and organic species, such as AMS-quantified PAHs and HOA, as the prominent components driving the OP assays in Fairbanks. Although the average $PM_{2.5}$ mass concentration of 14.4 $\mu g/m^3$ was only moderately higher in Fairbanks than in Atlanta and LA, the variability was much higher reaching over 80 $\mu g/m^3$ during extreme cold events (< -30°C). In terms of exposure, on a per volume of air basis, OP_v^{OH} was lowest in Fairbanks and highest in LA, whereas for OP_v^{DTT}, Fairbanks was higher than Atlanta and lower than LA. Normalizing by particle mass, a measure of particle intrinsic health-related properties, gave similar results. Differences in OP^{OH} can be attributed to concentrations of transition metals, which the OH assay is sensitive to. Both Fe and Cu concentrations and their fractions of mass were substantially lower in Fairbanks, consistent with low traffic density. OP^{DTT} is sensitive to both organic species mainly associated with incomplete combustion and transition metals. Lower transition metals in Fairbanks may have been compensated by higher concentrations of OA species (e.g., PAHs and related compounds) from residential wood combustion leading to higher levels of OP^{DTT} compared to Atlanta, but high metals in LA appear to drive higher OP^{OH} and OP^{DTT} there. These findings demonstrate OP provides a distinct perspective on particle health-related properties compared to $PM_{2.5}$ mass.

5SS.5

Aerosol Perturbations in the Upper Troposphere and Lower Stratosphere due to Volcanic and Wildfire Injections: Insights from the DCOTSS Airborne Mission. YAOWEI LI, John Dykema, Corey Pedersen, Jean-Paul Vernier, Michael Fromm, David Peterson, Xiaoli Shen, Nicole June, Amit Pandit, Jeffrey R. Pierce, Daniel Cziczo, Frank Keutsch, *Harvard University*

Aerosols in the upper troposphere and lower stratosphere (UT/LS, altitudes of approximately 7-18 km) modulate global radiative balance by scattering and absorbing radiation, as well as affecting the nucleation of ice clouds. Additionally, aerosols in the LS affect the protective ozone layer by providing heterogeneous surfaces for halogen activation reactions and N2O5 hydrolysis. The climate and chemical impacts of UTLS aerosols depend largely on their microphysical and chemical properties, which can be significantly altered by episodic events such as volcanic eruptions and large-scale wildfires.

The NASA Dynamics and Chemistry of the Summer Stratosphere (DCOTSS) airborne mission, conducted in 2021 and 2022 over North America, provided an opportunity for in-situ microphysical and chemical characterization of UTLS aerosols. With the NASA ER-2 high-altitude aircraft platform, particles were isokinetically sampled up to 22 km and aerosol size distributions (130-3000 nm) were measured by an optical particle spectrometer (DCOTSS Portable Optical Particle Spectrometer, DPOPS). Aerosol chemical composition were measured using the particle analysis by laser mass spectrometry-next generation (PALMS-NG) instrument. This dataset is valuable for characterizing background UTLS aerosols, as well as perturbations from volcanic and wildfire injections. Volcanic plumes from La Soufrière eruptions in April 2021 were sampled repeatedly in the stratosphere, enabling detailed analysis of their spatiotemporal evolutions and impacts on radiative forcing and ozone depletion. A few ER-2 encounters of wildfire smoke from pyrocumulonimbus (pyroCb) events occurred in the UT. Evolution of these smoke aerosols in the UT and their radiative impacts were investigated using an aerosol microphysical model and radiative transfer calculations.

5SS.6

Integrating AOD-based PM2.5 Retrieval, Land Use Regression, and Machine Learning to Estimate the Spatiotemporal Variation of Ions in PM2.5 across Taiwan. KANG LO, Yee-Lin Wu, Tang-Huang Lin, Chang-Fu Wu, *National Taiwan University*

The impact of various composition of ambient air particulate matter on the ecosystem and human health is one of the leading global issues. Mounting researches have engaged in modeling spatiotemporal variation on the components in the fine particles ($PM_{2.5}$). While being compared to the elements in $PM_{2.5}$ composition, however, the spatiotemporal prediction of ions in $PM_{2.5}$ which are crucial factors in the formation of secondary aerosols still remains limited. In this study, aerosol optical depth (AOD)-retrieved $PM_{2.5}$, land use regression (LUR), and machine learning algorithm, Extreme Gradient Boosting (XGBoost), were integrated to estimate the spatiotemporal variation of water-soluble ions (WSI) in $PM_{2.5}$. Monthly average $PM_{2.5}$ WSIs (SO_4^{2-}, NO_3^-, NH_4^+, Na^+, Cl^-, K^+, Ca^{2+}, and Mg^{2+}) were obtained from 31 air quality monitoring stations of Taiwan EPA from 2019 to 2021. Several datasets, including land use, road information, MODIS AOD, Himawari-8 AOD, Himawari-8 AOD-retrieved $PM_{2.5}$, MODIS Normalized Difference Vegetation Index (NDVI), elevation, stationary emission sources, demographic data, meteorological data, and distribution of temples, were collected as the features in the models. The results demonstrated that these models had good performance on predicting external datasets of SO_4^{2-} (adjusted $R^2 = 0.77$), NO_3^- (adjusted $R^2 = 0.84$), NH_4^+ (adjusted $R^2 = 0.83$), Na^+ (adjusted $R^2 = 0.76$), Cl^- (adjusted $R^2 = 0.59$), K^+ (adjusted $R^2 = 0.64$), and Ca^{2+} (adjusted $R^2 = 0.68$). The model had relatively poor performance on predicting external datasets of Mg^{2+} (adjusted $R^2 <0.5$). These findings suggest that the current approach could be a proper method to predict the spatiotemporal variation of WSIs in $PM_{2.5}$.

5SS.7

Evaluation of High-resolution GEOS-Chem Nested Grid Simulations over Africa Using a Novel Surface Aerosol and Gas Dataset and Satellite Observations.

DANIEL WESTERVELT, Benjamin Yang, *Columbia University*

Air pollution is a growing problem in Africa, with around 1 million premature deaths attributed to poor air quality in 2019 on the African continent. Although measurements of PM2.5 and gaseous air pollutants on the continent are very sparse, new efforts by both African and international organizations have increased public data availability in recent years. New networks of PM2.5 rely on both reference monitoring and consumer-grade low cost sensors, the latter of which, if well calibrated, have been proposed as a potential means of closing this data gap in Africa. These emerging datasets provide a unique opportunity to evaluate regional and global chemical transport models over Africa so that projections and predictions from such modeling efforts can be more reliable. We will present an overview of these new datasets that span the African continent in at least 15 countries and cover total PM2.5, NOx, and O3. We also present simulations of atmospheric chemistry, emissions, transport, deposition, and meteorology using the GEOS-Chem chemical transport model. We employ a 25 by 25-kilometer horizontal spatial resolution regional nested simulation over equatorial Africa and simulate meteorological years 2021 and 2022, allowing us to take advantage of novel surface observations established in only the last few years. Emissions in Africa are from the DICE-Africa inventory. We evaluate daily, monthly, and hourly surface PM2.5 in several cities, including: Accra, Ghana; Lomé, Togo; Kinshasa, DRC; Brazzaville, ROC; Kampala, Uganda; Nairobi, Kenya; Addis Ababa, Ethiopia; and more. Initial results show that this high-resolution model reproduces surface PM2.5 reasonably well. In Accra, March – October 2021 modeled surface 24-hour mean PM2.5 was moderately well correlated with surface observations (r2 = 0.57). Overall, the model underpredicted PM2.5 in March-October 2021, with an average of 23.6 µg m^{-3} observed PM2.5 versus 18.8 predicted by GEOS-Chem. Finally, we leverage satellite observations of NO2 from TROPOMI and AOD from MODIS to compare to both the GEOS-Chem model output and the ground-based observations. These findings will help inform and ultimately improve air quality modeling efforts over Africa.

5UA.1

Comparative Analysis of Cooking Emission Markers in Field Campaigns using the AMS and the Offline FIGAERO-CIMS Method.

SUNHYE KIM, Abhishek Anand, Pavithra Ethi Rajan, Jenna DeVivo, Albert A. Presto, *Carnegie Mellon University*

Cooking emissions serve as a significant contributor to Primary Organic Aerosol (POA) in urban environments, which is frequently quantified using the Aerosol Mass Spectrometer (AMS). Despite our recent AMS measurements revealing notable variations in Cooking Organic Aerosol (COA) composition, particularly a substantial presence of reduced N fragments at specific cooking sources, the application of the Chemical Ionization time-of-flight Mass Spectrometer (CIMS) can provide additional molecular insights into cooking emissions through the minimal fragmentation of molecular compounds.

During the summer of 2021, we investigated the OA concentrations and compositions across urban locations characterized by diverse levels of nearby anthropogenic emissions. Real-time measurements of NR-PM_1 were obtained via AMS using a mobile laboratory, while $PM_{2.5}$ samples were gathered on filters for subsequent analysis with iodide-based CIMS utilizing Filter Inlet for Gases and AEROsols (FIGAERO).

This study aims to identify cooking markers detected by the CIMS that exhibit robust correlations with both well-established COA markers identified from the AMS and the COA factor derived from the Positive Matrix Factorization (PMF) analysis. To achieve this, a list of cooking markers generated from prior research was utilized. Preliminary CIMS results from a high cooking activity source indicated that 53 % of the cooking markers displayed the highest signal at noon, followed by evening (31 %), morning (9.4 %), and afternoon (6.3 %), corresponding to the COA factor's diurnal pattern observed in the AMS-PMF analysis. Notably, lactic acid ($C_3H_6O_3$) and palmitic acid ($C_{16}H_{32}O_2$) exhibited prominent peaks throughout the day.

This analysis will reveal spatiotemporal variations in correlations among COA markers by employing both CIMS and AMS, enabling a deeper understanding of potential factors influencing their relationships. Consequently, this integrated approach will not only enhance our understanding of the complexities of COA but also demonstrate how the CIMS can complement the molecular information detected by the AMS.

5UA.2

Elemental Content of Brake and Tire Wear PM2.5 and PM10 at Near-Road Environments. BRENDA LOPEZ, Xiaoliang Wang, L.-W. Antony Chen, Tianyi Ma, David Mendez-Jimenez, Ling Cobb, Chas Frederickson, Ting Fang, Brian Hwang, Manabu Shiraiwa, Minhan Park, Kihong Park, Qi Yao, Seungju Yoon, Heejung Jung, *University of California, Riverside*

Brake and tire wear particulate matter (PM) have become the dominating source of traffic related emissions in California, USA. The EMission FACtor (EMFAC) model from California Air Resources Board predicts these non-tailpipe emissions to remain dominant contributors of on-road PM. Brake and tire wear contain traces of heavy metals, therefore may dominate metal emissions near major roadways and highways. This creates concern as these particulate sources can increase toxicity and impact the health of exposed populations and nearby communities.

The objective of this study is to assess the level of exposure of non-tailpipe emissions in near-road environments. The study investigates metal contents and size distributions found in PM2.5 and PM10 measurements next to two major highways in California, USA.

Real time and gravimetric measurements occurred over a two-week period in the winter of 2020 prior to the COVID-19 pandemic. PM measurements were collected at the proximity of both sides of the highways to subtract urban background at the measurement location. This study is a part of a Real-World Tire and Brake Wear Emissions Project funded by California Air Resources Board. The results of this analysis are in conjunction to chemical analysis, source apportionment, and health effects of the particles in the near road environment studies by project collaborators [1-3]. The presentation includes the signature brake mode in particle size distributions measured near-road, size speciated elemental analysis to identify markers for brake, tire, and road dust.

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5UA.3

Tire Wear Emissions by Highways: Impact of Season and Surface Type. Jason Miech, Pierre Herckes, MATTHEW FRASER, *Arizona State University*

With the increasing number of electric vehicles taking to the roads, the impact of tailpipe emissions on air quality will decrease, while resuspended road dust, and brake/tire wear will become more significant. This study seeks to quantify PM_{10} emissions from tire wear under a range of real highway conditions with measurements across different seasons and roadway surface type. To specifically quantify tire wear particles, PM_{10} filter samples were collected on highway overpasses and analyzed for tire wear markers such as benzothiazoles and phenylenediamines using GC-MS. To account for mixing and transport between the highway surface and the overpass, commercial road flares, which emit strontium, were burned on the highway surface to act as a tracer from a line source, with ambient Sr measured by ICP-MS. Additional factors such as wind speed and direction, and volume and composition of traffic were also measured. To convert between tire marker and tire wear we collected and analyzed source samples from a variety of passenger and truck tires and used the traffic composition to develop a weighted average composition value for the conversion. The final calculated PM_{10} tire wear emission rates will be compared to emission models calculating PM_{10} tire wear emission rates.

5UA.4

Characterization of In-Use Heavy-Duty Diesel Truck Pollutant Emission Rates and Emission Control Technology Performance. CHELSEA V. PREBLE, Rebecca A. Sugrue, Thomas W. Kirchstetter, *University of California, Berkeley*

Diesel particle filter (DPF) and selective catalytic reduction (SCR) emission control systems are standard equipment on new heavy-duty diesel trucks (HDDTs) to reduce emitted particulate matter (PM) and nitrogen oxides ($NO_x = NO + NO_2$), respectively. In California, statewide regulations have accelerated fleet turnover and the adoption of these emission controls, such that all HDDTs must now be equipped with 2010 and newer engines that are DPF- and SCR-equipped. Prior work has shown that on-road emissions have decreased over the last decade as DPFs and SCR became widely used (Preble et al., *ES&T* 2015; 2018; 2019). However, that work also showed that a majority of pollution is emitted by a minority of trucks, and that in-use emissions can be higher than corresponding emission standards and mobile source emission model predictions.

To evaluate the impact of DPF and SCR systems on HDDTs under real-world conditions, tailpipe exhaust emissions from thousands of in-use trucks were measured at three California locations between 2019–2023. Each location captured a different driving mode: (1) entering a port terminal entrance, (2) traveling along an urban arterial street, and (3) driving up a 4% gradient on a highway. Fuel-based emission factors (g kg^{-1}) of black carbon (BC) and key nitrogenous species (NO_x, NO_2, nitrous oxide (N_2O), ammonia (NH_3)) were calculated via a carbon balance method on a truck-by-truck basis, using an exhaust plume capture approach that related pollutant concentrations measured at high time resolution (≥1 Hz) to above-background carbon dioxide (CO_2) concentrations. Emission profiles for each truck were linked to engine model year and installed after-treatment controls by matching recorded license plates to state-managed truck databases.

As the statewide regulations have been phased in over the past decade, a majority of HDDTs are now equipped with DPFs and SCR. This transformation of the on-road fleet has driven down fleet-average BC and NO_x emission factors by ~80% between 2010 (pre-regulation) and 2021. Across all sites, trucks equipped with both SCR and DPF (2010+ engines) had lower BC emissions than those 2007–2009 MY trucks with only a DPF, even though all 2007+ engines must meet the same EPA standard. This difference by technology seems to be impacted by driving mode, increasing with assumed engine load: on average, BC emissions by 2010 and newer engines are 35% lower at the Terminal Entrance, 61% lower at the Arterial Road site, and 90% lower on the highway, compared to 2007–2009 engines with a DPF alone. Notable increases in BC from trucks with pre-2010 engines without SCR indicate reduced DPF performance as systems age. Differences in engine tuning and filter regeneration strategy are likely factors that may contribute to the observed DPF deterioration for 2007–2009 engines compared to 2010 and newer engines that are also equipped with SCR.

5UA.5

Spatial Variations and Health Implications of Resuspended Road Dust Particulate Matter. CHEOL H. JEONG, Cuilian Fang, Eeman Abdulkadir, Nathan Hilker, Taylor Edwards, Greg J. Evans, *SOCAAR, University of Toronto*

Non-tailpipe particulate matter (NTP), including road dust and brake/tire dust, are of increasing interest due to their potential impact on air pollution as efforts to reduce tailpipe emissions and promote electrification become more stringent. We investigated spatial variations of NTP across different types of roads and neighborhoods to understand population exposure and its contribution to ambient particulate matter (PM). Trace metals and oxidative potential (OP) analysis were conducted to infer NTP's impact on human health.

Mobile measurements using an electric vehicle equipped with high-time resolution instruments were conducted to measure $PM_{2.5}$, PM_{10}, the metal components of $PM_{2.5}$, ultrafine particles, black carbon, and carbon dioxide. Tandem sampling lines were mounted on the rear window and wheel-well area to measure PM resuspended from the road surface. Extensive mobile sampling was conducted to explore spatial variability in the concentrations of resuspended PM across residential and arterial roads, highways, and in school areas located near industrial, commercial, highway, and green space areas. The effectiveness of street sweeping equipped with vacuuming, blooms, and water spraying capabilities in reducing ambient and resuspended PM levels was also evaluated.

Resuspended road dust PM exhibited distinct spatial variations, with higher dust loadings in local school streets than on major roads and highways. Nearby construction, renovation, and landscaping activities likely caused the increase in resuspended road dust, rather than land use zoning near the neighborhoods. More targeted strategies should be developed to mitigate the impact of resuspended road dust around schools. Furthermore, positive correlations were observed between OP assays and trace metals identified in NTP, suggesting higher redox activity with NTP leading to OP values much higher than those found in local ambient samples.

5UA.6

High Time-Resolution Measurements of Particulate Metals in Environmental Justice Communities. HANYANG LI, Miguel Zavala-Perez, Wayne Linklater, Anthony S. Wexler, *San Diego State University*

Among the various air pollutants that can affect environmental justice communities, toxic metals are a big concern due to their potential health effects and the associated odor complaints. Although anthropogenic metal emissions have been identified for a long time, studies of human exposure to heavy metals have been hindered by the lack of a real-time metal monitor. To fill this gap, we have applied the technology of spark-induced breakdown spectroscopy to develop a Toxic-metal Aerosol Real-Time Analysis (TARTA) that offers a low-cost and real-time alternative to existing ambient toxic metal analyzers in the market.

In this presentation, we are going to report our first results from the application of TARTA in community air quality monitoring. The monitored community sites are within California's Imperial Valley, Sacramento, and San Ysidro. Low-income people, people of color, tribal people, immigrants, and other disadvantaged populations in California face a large number of severe environmental and health risks. The air quality in these communities is significantly degraded by emissions from transportation, industrial facilities, energy production, and industrialized agriculture. In addition, the Imperial Valley and San Ysidro's locations along the US-Mexico border and several high-volume border crossing corridors also put their residents at high risk for air quality impacts. Our measurements will reveal the spatial and temporal variations of individual metals in different communities and assess community-specific emission sources of the observed elements using Positive Matrix Factorization (PMF) and Principal Component Analysis (PCA).

5UA.7

Community-Scale Monitoring of Particle-Bound Metals in Two Environmental Justice (EJ) Communities in the South Coast Air Basin: I. Mobile Monitoring Results. MOHAMMAD SOWLAT, Christopher Lim, Steven Boddeker, Julia Montoya-Aguilera, Faraz Ahangar, Sina Hasheminassab, Payam Pakbin, Andrea Polidori, Jason Low, *South Coast Air Quality Management District*

Ambient particulate metals are an important category of Hazardous Air Pollutants (HAPs) with known detrimental impacts on human health. Given the large spatio-temporal variability in ambient concentrations of particulate metals, information from sparsely distributed fixed air monitoring networks may not adequately reflect their levels and trends at the local level, especially in disproportionately impacted (i.e., Environmental Justice (EJ)) communities. The East and Southeast Los Angeles communities are two EJ communities in the South Coast Air Basin (SCAB) designated by California Air Resources Board (CARB) to be part of Assembly Bill (AB) 617, a state-wide program established to reduce the impact of air pollution in EJ communities. In these communities, several known sources of particulate metals are in close proximity to residential areas and sensitive receptors, increasing the level of exposure to these pollutants. Aiming to characterize levels and sources of ambient particle-bound metals in these communities, a year-long air monitoring campaign was conducted, comprising stationary and hyperlocal mobile monitoring of multi-metals. The mobile monitoring surveys provide granular data on the community-scale variation in the concentrations of metals, whereas the stationary monitoring data provide information on their temporal trends and longer-term variations in their concentrations. This presentation focuses on the hyperlocal mobile monitoring component of this campaign, using a recently developed multi-metals mobile platform (MMMP). The presentation provides an overview of the multi-step monitoring strategy employed in this campaign and the preliminary results from the surveys conducted. This discussion explains how the data has been used to elucidate potential sources of trace metals and indicate how the results are being used in support of further actions to reduce emissions and exposure to ambient particle-bound metals in these communities. In an accompanying presentation, results on the temporal trends of particulate metals measured at two monitoring stations in these communities will be discussed.

6AC.1

Molecularly Revealing 3D Structure of Organic Aerosol Particles Using Mass Spectrometry Imaging. ZIHUA ZHU, Fan Mei, Jeffrey Dhas, Zezhen Cheng, *Pacific Northwest National Laboratory*

Organic aerosol particles are of great importance because they are highly prevalent in atmosphere, significantly affect our planet's radiation budget, and actively influence human health. Understanding 3-demensional (3D) structure of aerosol particles is critical, because heterogeneous mixing states lead to different activities of light diffraction and water condensation/ice nucleation. However, it has been challenging to reveal 3D structure of organic aerosols at a molecular level. For example, aerosol mass spectrometry can provide molecular information, but it is majorly a bulk analysis tool without any useful spatial resolution. Scanning electron microscope and transmission electron microscopy can provide delicate nanoscale resolution images, while no molecular information is available. Time-of-flight secondary ion mass spectrometry (ToF-SIMS) is a powerful surface analysis tool, providing both nanoscale spatial resolution and molecular recognition capability. We have recently used it to examine PM2.5 particles collected from a typical pollution case in Beijing wintertime.[1] In this presentation, we show ToF-SIMS 3D molecular imaging data of aerosol particles collected on October 14, 2021, at ARM SGP site in Oklahoma. A large amount of solid shell-liquid vegetable oil core organic aerosol particles are observed. As far as we know, such structure was never reported before. Our results not only provide interesting information to understand organic aerosol formation and aging mechanism, but also open a new door for investigation of 3D structure of organic aerosol particles at a molecular level.

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6AC.2

Reactions of Nitrate in Aqueous Droplets Initiated by Triplet Energy Transfer. PYEONGEUN KIM, Christian Boothby, Vicki Grassian, Robert Continetti, *University of California San Diego*

In-situ Raman spectroscopy of single levitated aqueous microdroplets irradiated by dual-beam (266 and 532 nm) lasers demonstrates that nitrate anion can be depleted in the droplet through an energy transfer mechanism following excitation of sulfanilic acid (SA), a UV-absorbing aromatic organic compound. Upon 266 nm irradiation, fast decrease of nitrate concentration was observed when SA is present in the droplet. This photo-induced reaction of nitrate occurs without the direct photolysis. Instead, the rate of nitrate depletion was found to be dependent on the initial concentration of SA and pH of the droplet. Based on the absorption-emission spectral analysis and time dependent density functional theory (TD-DFT) excited-state energy calculations, triplet-triplet energy transfer between SA and nitrate is proposed as the underlying mechanism for the enhanced depletion of nitrate in aqueous microdroplets. These results suggest that energy transfer mechanisms initiated by light-absorbing organic molecules may play a significant role in nitrate photochemistry.

6AC.3

Structures and Formation Mechanisms of Molecular Products in Pinene Secondary Organic Aerosol. CHRISTOPHER KENSETH, Samir Rezgui, Jing Chen, Nathan Dalleska, Henrik Kjaergaard, Brian Stoltz, Joel A. Thornton, Paul Wennberg, John Seinfeld, *California Institute of Technology*

For decades, advanced mass spectrometric techniques have been employed to characterize the molecular composition of secondary organic aerosol (SOA) formed from the oxidation of α-pinene and β-pinene. Due to a lack of authentic standards, however, the structures of identified molecular products are typically not known but only inferred from accurate mass/fragmentation data. As a result, mechanistic understanding of their formation and evolution remains unconstrained. Here, we unambiguously determine the structures of the most abundant monomeric and dimeric products identified using liquid chromatography/electrospray ionization mass spectrometry (LC/ESI-MS) in SOA from ozonolysis of α-pinene and β-pinene through independent synthesis of authentic standards. Based on targeted environmental chamber experiments featuring ^{2}H, ^{13}C, and ^{18}O isotopic labeling together with chemical ionization mass spectrometry (CIMS) and LC/ESI-MS for analysis of gas/particle-phase molecular composition, we elucidate their gas- and/or particle-phase formation mechanisms. Determination of the structures and formation mechanisms of these key pinene SOA constituents resolves a longstanding puzzle in atmospheric aerosol chemistry and rationalizes a number of notable experimental and ambient observations from past studies.

6AC.4

Heterogeneous Reaction of Protein Samples with Ambient Urban Air: Ratio of Nitration and Oligomerization Products. Rachel L. Davey, Alyssa Knaus, Paola Gascot, ALEKSANDRA VOLKOVA, Erick Mattson, J. Alex Huffman, *University of Denver*

Ambient air pollutants like ozone (O_3) and nitrogen dioxide (NO_2) can act as reactive oxygen species (ROS) and reactive nitrogen species (RNS) to chemically react with proteins in the atmosphere. Such post-translational modifications (PTMs) may promote changes in physiological response upon inhalation and on biological surfaces. For example, the observed increase in allergic disease, including allergic rhinitis and asthma, has been hypothesized to have a link to the reaction of allergens with ROS/RNS in the atmosphere. Nitration (NTyr) is a PTM that forms via the reaction with O_3 and NO_2 and has been shown to exacerbate the allergenic potential in rat models. NTyr formation also competes with oligomerization (dityrosine cross-linking, DiTyr), which has also been shown to form in the presence of O_3. We previously reported preliminary results showing the nitration of bovine serum albumin (BSA) in ambient air via O_3 and NO_2. Here we present more extensive results correlating NTyr and DiTyr formation to concentrations of O_3 and ROS observed at sites in the urban and suburban vicinity of Denver, Colorado, which is among the most a highly O_3 polluted regions in the United States. Nitration degree values up to 5.5% were observed, compared to oligomerization degrees of 56.1%, showing the oligomerization pathways as atmospherically significant. The ratio of NTyr to DiTyr was also observed to scale with the O_3 and ROS concentrations, suggesting that the reaction products on bioaerosol surfaces and at the atmosphere-biosphere interface will vary, depending on geography and atmospheric conditions.

6AC.5

Exploring Nighttime Uptake of HONO and Nitrite Oxidation on Coarse Mode Aqueous Aerosol Particles Utilizing the Aerosol Optical Tweezers. Luke Monroe, Jack Hall, Graham Thornhill, RYAN SULLIVAN, *Carnegie Mellon University*

Nitrous acid (HONO) acts as an important reservoir species for inorganic nitrogen in the atmosphere and a potential source of nitrite in aerosol particles. HONO rapidly photolyzes in the morning to provide a significant source of NO_x and hydroxyl radical prior to peak daylight production. Sink processes for HONO can take place in the gas phase but are often accelerated by surface adsorption, which can be pH dependent as HONO is volatile in its protonated state. Direct measurement of these species is difficult due to the instability and surface chemistry of nitrous acid in instrument inlets. The aerosol optical tweezers (AOT) can use cavity-enhanced Raman spectroscopy and whispering gallery modes to probe chemical information, droplet size, and droplet refractive index of single-levitated droplets in real-time using measurements that do not perturb the droplet's properties or reaction kinetics. To better understand the ability of HONO to partition to supermicron aqueous aerosols and the kinetics of nitrite oxidation to nitrate at night, the AOT was used to investigate trapped droplets of varying chemical compositions, morphology, and pH under HONO exposure in oxic and anoxic conditions. The droplet accelerated kinetics of nitrite oxidation in a droplet were investigated under conditions simulating polluted and pristine atmospheric conditions and compared to bulk rates. The results presented here offer new insight on the nighttime sink processes of HONO and nitrite in coarse mode aqueous aerosol particles, suggesting that HONO uptake to supermicron aerosol may be an unrecognized sink of NO_y that also facilitates aqueous chemistry of nitrite.

6AC.6

Dynamics at the Air-Water Interface Determine the Ozonolysis Kinetics of Anions in Single Microdroplets. ALEXANDER PROPHET, Kevin R. Wilson, *Lawrence Berkeley National Laboratory*

Chemical and physical transformations of aerosol are greatly influenced by heterogeneous reactions occurring both within the particle interior and at the surface. However, the molecular details of reactive gas uptake into aerosol may be obscured by overlapping timescales of chemical reactions at the surface and physical transport processes such as adsorption and solvation. Here we present ozonolysis kinetics for a set of inorganic anions (I^-, $S_2O_3^{2-}$, SO_3^{2-}, SCN^-) contained in levitated microdroplets to explore the effects of ion surface propensity and bimolecular ozonolysis rates on the overall droplet reactivity and uptake of ozone. Measurements on single microdroplets are performed using a quadrupole electrodynamic trap coupled to mass spectrometry to monitor reaction progress during trace ozone exposure. Kinetic and molecular dynamics simulations are used to study the underlying physical steps governing ozone equilibration times at the air-water interface with emphasis on how gas adsorption, solvation, and diffusion are coupled to chemical reactions occurring on the surface and throughout the particle. Analytical expressions describing heterogenous ozonolysis at the droplet surface and in the bulk are used to construct a general characterization of heterogeneous chemistry occurring in liquid aerosol for a range of surface reactivies and droplet compositions.

6AC.7

Assessing the Impact of Atmospheric Photochemical Aging on Organic Aerosol Tracers Derived From Burning African Biomass Relevant to Botswana. ADRIENNE LAMBERT, Cade Christensen, Vaios Moschos, Megan Mouton, MarkieSha James, Marc Fiddler, Barbara Turpin, Solomon Bililign, Jason Surratt, *University of North Carolina at Chapel Hill*

As a result of climate change, wildfires are becoming increasingly frequent and intense, leading to the production of biomass burning (BB)-derived organic aerosols (BBOA). These fine aerosol particles can have negative impacts on human health. Despite accounting for over 50% of worldwide BB emissions, there is a lack of systematic laboratory studies analyzing organic aerosol tracers derived from the burning of African biomass. This study aims to examine how atmospheric photochemical aging alters the chemical composition of freshly-generated BBOA tracers from well-known and abundant African biomass fuels, especially those relevant to Botswana. Gas chromatography interfaced to electron ionization quadrupole mass spectrometry (GC/EI-MS) was used to analyze aerosol filters collected from both fresh and photochemically-aged BB emissions of six different biomass fuel types (i.e., Botswana fuel mixture, *Cordia africana*, *Baikiaea plurijuga*, *Acacia erioloba*, *Colophospermum mopane*, and Ethiopian cow dung) generated from a furnace that mimicked smoldering conditions. The furnace effluent was injected into the NCA&T smog chamber at a constant relative humidity of 70% ± 3%. The abundances of 17 known BBOA tracer compounds (e.g., levoglucosan, mannosan, coniferyl alcohol, lactic acid, etc.) were compared between the fresh and photochemically-aged BB emissions from each of the 6 fuel types, and significant differences were found. In addition, a number of ambient fine particulate matter samples collected from Botswana at the start of the southern hemisphere fire season were also analyzed by GC/EI-MS in order to identify the BBOA tracers from our laboratory studies. Our results will likely help to increase our fundamental understanding of the chemical transformations of BB emissions in Botswana after atmospheric photochemical aging.

6AC.8

Unexpectedly Rapid Removal of Sodium Methanesulfonate upon Heterogeneous OH Oxidation Revealed by Smog Chamber Experiment. SZE IN MADELEINE NG, Zi Jun Li, Angela Buchholz, Iida Pullinen, Snehitha M. Kommula, Aki Nissinen, Mitchell Alton, Pasi Yli-Pirilä, Merete Bilde, Annele Virtanen, Marianne Glasius, Siegfried Schobesberger, Man Nin Chan, *The Chinese University of Hong Kong*

The atmospheric level ratio of methanesulfonic acid (MSA) to non-sea-salt sulfate (nss-SO_4^{2-}) is often used as a tracer for marine biological activity, under the assumption that MSA is relatively long-lived. However, this assumption has been challenged by oxidation flow reactors (OFR) experiments probing the chemical transformation of MSA via heterogeneous oxidation by hydroxyl radical (OH), which produces nss-SO_4^{2-} and formaldehyde.

To better assess the chemical lifetime of MSA, we employed an environmental chamber at 65 % relative humidity (RH) and 298 K to explore heterogeneous OH oxidation of sodium methanesulfonate (CH_3SO_3Na, NaMS), the sodium salt of MSA abundant in the marine boundary layer. Different from OFR, our chamber allowed for atmospherically relevant levels of reactants ([OH]= $(9.99 \pm 0.76) \times 10^6$ molecules cm^{-3}) and long reaction time, and therefore provided a more accurate estimation of reaction kinetics and time-resolved products. Composition and mass of aerosol particles were simultaneously monitored by real-time techniques including an aerosol mass spectrometer (AMS), an extractive electrospray ionization mass spectrometer (EESI-MS), and a scanning mobility particle sizer (SMPS). In parallel, particles were collected using a spot sampler for analysis with liquid chromatography-mass spectrometry (LC-MS). Gas-phase species were measured by a proton-transfer-reaction ionization mass spectrometer (PTR-MS).

We observed rapid wall loss-corrected decay of NaMS, with an effective reaction rate constant k and an initial effective OH uptake coefficient γeff respectively calculated as $(1.28 \pm 0.07) \times 10^{-12}$ cm^3 $molecule^{-1}$ s^{-1} and 1.26 ± 0.03, indicative of secondary reactions. This corresponds to a chemical lifetime of around 6 days, dependent on ambient OH level. We speculate that current climate models may have underestimated the conversion of MSA to nss-SO_4^{2-} via heterogeneous oxidation, and future work is necessary to re-evaluate the robustness of MSA to nss-SO_4^{2-} ratio as a proxy for marine sulfur production.

6BA.1

Single Particle Measurements and Machine Learning Approaches to Study Vertical Distribution of Biological Particles. SWARUP CHINA, Yingxiao Zhang, Nurun Nahar Lata, Zezhen Cheng, Darielle Dexheimer, Fan Mei, *Pacific Northwest National Laboratory*

The vertical distribution of aerosol in the boundary layer and their chemical composition is important for accurately estimating aerosol climatic effects. Biological particles produced by land–biosphere–atmosphere interactions challenge understanding of the sources and formation mechanisms of biological aerosol. Primary biological particles such as spores and pollen can rupture near the surface in dry and windy conditions or when airborne under high humidity conditions, resulting in the atmospheric release of fragments that vary widely in diameter ranging from several nanometers to submicron. In this study we use single particle analysis along with various machine learning models to quantify the abundance of biological particles in atmospheric samples. Atmospheric particles are collected at different altitudes using a tethered balloon system. Single particle analysis is performed using micro-spectroscopy techniques to determine the size, morphology and elemental composition of particles. Machine learning models are trained and validated with known composition, size and morphological features of biological particles. Then we apply the machine learning models to determine the contribution of biological particles in the particle populations. This study improves our current understanding of the vertical distribution of biological particles and their impact on climate system.

6BA.2

Antibiotic Resistance Genes in Air Near Farms. DAVID KORMOS, Amy Pruden, Gabriel Isaacman-VanWertz, Jactone Ogejo, Linsey Marr, *Virginia Tech*

The spread of antimicrobial resistance is a growing global threat according to the World Health Organization. Previous studies have mainly focused on antibiotic resistant genes (ARGs) in water and soil, while less is known about ARGs in the atmosphere. Their potential for long-distance transport is especially concerning. We are characterizing ARG emissions to the atmosphere at a swine farm and a dairy farm over the course of a year. We collected particles using a custom-built sampler with a cascade impactor and collected culturable bacteria using a viable Andersen impactor. At the swine farm, concentrations of total bacteria in terms of 16S rRNA ranged from 10^5gc/m^3 to 10^8gc/m^3, with concentrations decreasing as particle size decreased between 5 and 0.5µm. The concentration of the ARG *sul1* reached a maximum of ~10^4gc/m^3 and decreased with particle size. At the dairy farm, total 16S rRNA concentrations ranged from ~10^5gc/m^3 to ~10^6gc/m^3 and decreased with distance from 0 to 100m away from the animal pen. The concentration of *sul1* decreased as particle size decreased and was highest at an upwind site and at 0 and 50 m downwind of the sick pen. No culturable *E. Coli* was observed at the dairy farm in fall and winter, but growth on *S. aureus*-selective medium was observed in particles >1.1µm in the fall and >3.3µm in the winter. The ratio of resistant to non-resistant bacteria was higher in the fall. At the swine farm, culturable *E. Coli* was observed in particles >2.1µm and colonies on *S. aureus*-selective media were observed in particles >1.1µm in fall and winter. The ratio of resistant to non-resistant *E. Coli* colonies was the same in fall and winter and was higher than the ratio of resistant to non-resistant bacteria on the *S. aureus*-selective media.

6BA.3

Behaviors of Gram-Positive and Gram-Negative Bacteria after Exposure to Aerosolization Stress.

BROOKE SMITH, Maria King, *Texas A&M University*

This study aimed to investigate the behavior of Bacillus globigii, a simulant for the gram-positive pathogen Bacillus anthracis, in response to environmental conditions during aerosolization. This study was conducted to build upon previous work by the authors which showed that aerosolization triggered antibiotic resistance in Escherichia coli (E. coli) MG1655, a gram-negative pathogen simulant. B. globigii spore suspensions were aerosolized at different environmental conditions for 5 different time durations into a sterile, air-tight chamber and collected using a wetted-wall cyclone bioaerosol collector (WWC). Each sample was analyzed based on its response to each environmental factor using antibiotic susceptibility testing and polymerase chain reaction (PCR). In comparison to E. coli the B. globigii behaved similarly with a decrease in development of resistance during 10-minute testing versus shorter and longer durations. These results were also consistent with culturability, showing that the environmental conditions during 10 minutes of aerosolization could be optimal for gram-positive and gram-negative bacteria to decrease the amount of resistance. The B. globigii showed a 28% increase in resistance for samples aerosolized for shorter and longer times compared to the optimal time of 10-minute aerosolization. B. globigii showed resistance mostly to cell wall synthesis inhibitors ampicillin, cephalothin and imipenem which increased nearly 100% after aerosolization. This is an important study to delineate and compare the response of gram-positive and gram-negative bacteria to aerosolization stress and determine which mechanisms are deployed by antibiotic resistant bacteria.

6BA.4

Abundance, Properties and Seasonal Variation of Bioaerosol Particles Observed during the SAIL Campaign.

ABU SAYEED MD SHAWON, Katherine Benedict, Allison Aiken, *Los Alamos National Laboratory*

Bioaerosol particles such as pollen, fungal-spores, and bacteria are globally ubiquitous. They impact our climate, ecosystem, and human health, and yet they are largely uncharacterized in real-time in the atmosphere. Bioaerosol can impact cloud formation and radiative impacts by acting as ice nuclei or cloud condensation nuclei. They can also affect ecosystems or human health through aerial dispersion and transport. Though these impacts are well known, there is still a gap in understanding their abundance, properties and interactions for different meteorologies and ecosystems, especially due to the lack of long-term online ambient data.

We deployed a Wideband Integrated Bioaerosol Sensor (WIBS-Neo, DMT) at Crested Butte Mountain to the Surface Atmosphere Integrated Field Laboratory (SAIL) campaign. The WIBS is a single particle measurement system that facilitates two fluorescence lamps and complementary detectors to identify biogenic particles and specify their properties with high temporal resolution. As a U.S. DOE Atmospheric Radiation Measurement (ARM) campaign, SAIL is focused on atmospheric and land-atmosphere processes and their impacts on the mountain hydrology of the East River Watershed in Colorado. During this campaign, our focus was to understand the abundance and properties of bioaerosol in a high-elevation (~9500 ft) mountainous terrain, and how these properties vary with meteorological conditions, aerosol sources and seasonal variations. We present the physical properties of different types of bioaerosol particles sampled from June 15 to September 13, 2022, and from March 22 to June 15, 2023 using WIBS, and compare our data with collocated measurements from the ARM Aerosol Observation System (AOS). In this presentation, we will discuss how the abundance, types, and diurnal cycle of bioaerosol varies during the Spring and Summer, and how different regional events may affect these properties. To our knowledge, these are the first high time resolution measurements of bioaerosol made within mountainous terrain.

6BA.5

On the Road: Car Cabin Air Filters Reveal Geographic Trends in Antimicrobial Resistance Genes across Canada. PAUL GEORGE, Marc Veillette, Florent Rossi, Amélia Bélanger Cayouette, Samantha Leclerc, Maosheng Yao, Nathalie Turgeon, Caroline Duchaine, *Université Laval*

Antimicrobial resistant bacteria can spread throughout the wider environment through the air in bioaerosols originating from anthropogenic sources, such as agriculture, wastewater treatment, or hospitals. Upon deposition in a new environment, they may pass antimicrobial resistance genes (ARGs) to other bacteria via horizontal gene transfer. Monitoring the spread of ARGs requires multidisciplinary approaches in a One Health context as understanding the diversity of environmental ARGs and their potential sources is necessary to make actionable policy to combat their spread. Here, we apply a recently developed method using car cabin air filters as monitors of airborne bacteria and ARGs genes across Canada. We collected 477 filters from 51 locations. For each filter, local population, agricultural, and environmental data was collected from publicly available government sources. We developed a bespoke processing methodology to extract dust from filters for DNA extraction. We then quantified copy numbers of 16S and the ARGs using high-throughput qPCR. Bacterial biomass and ARG copy numbers were highest in Ontario and lowest in Canada's Territories. This is driven by a positive correlation with human population. Quinolones were the most abundance genes across all regions since they are plasmid-associated. Upon their removal, regional trends became clearer. Tetracycline resistance genes showed a strong positive relationship with poultry and pig populations, but also elevation. This may be explained by their natural prevalence in soils as well as their use in agriculture. Sulfonamide, macrolinde, and tetracycline resistance genes were significantly correlated with regional livestock populations, as were mobile genetic elements. Aminoglycoside resistance genes were positively correlated with human populations. ARG richness was highest in Ontario and the prairie provinces and lowest in the Atlantic provinces. 16S sequencing results are incoming and will be presented to complement these findings and further explain the biological reasons behind ARG distributions on the national-scale.

6BA.6

Autofluorescence Measurements of Primary Biological Aerosol Particles during Winter in Interior Alaska: The Influence of Biomass Burning. KAITLYN MCKINNEY, Saravanan Kanagaratnam, Anastasia Hewitt, Raghu Betha, Venky Shankar, *Texas Tech University*

Primary Biological Aerosol Particles (PBAPs) are significant contributors to climate change and can adversely impact human health, making it essential to understand their distribution, proliferation, and concentrations. While several methods exist to measure bioaerosols, autofluorescence methods have distinct advantages in high sensitivity and real-time monitoring. However, the major limitation of this measurement method is the interference from non-biological particles and anthropogenic emissions. To address this challenge, we developed an approach that involves using concurrent measurements of autofluorescence and chemical analysis of particle filter samples to quantify and isolate the interference of biomass-burning particles. This approach was applied to quantify the types, concentrations, and temporal distribution of bioaerosols during wintertime in the City of North Pole, Alaska. The results of this study show that fluorescent aerosol particles (FAPs) less than 0.75µm in diameter that are excited by wavelengths of either 370 nm or 280 nm and fluorescent emission wavelengths of 420 nm to 650 nm (Type-B and Type-C) are primarily biomass-burning particles. FAPs in this category make up 54% of the total FAPs. FAPs measured in these wavelengths have weak peak fluorescent intensities and are largely made of smaller particles. These findings fit a pattern of human activity in the local population. The concurrent measurement approach used in this study can be applied to other regions to understand the distribution and concentrations of bioaerosols further. Overall, this study provides valuable insights into the dynamics and variations of bioaerosols and demonstrates the importance of using accurate methods to measure them.

6BA.7

Targeted Virus Analysis of Aerosol Emissions from Wastewater Treatment Plant. SHRUTI CHOUDHARY, Ayaaz Amirali, Darlington Imhanzuaria, Mark Sharkey, Stephan Schurer, Dusica Vidovic, Chris Mason, Helena Solo-Gabriele, Pratim Biswas, *University of Miami*

Studies have shown that wastewater provides rich insights into pathogenic viruses, bacteria and protozoa released to sewage from human populations. Few studies however have evaluated the aerosols generated from wastewater. Aerosols can be generated during bubble bursting at wastewater treatment plants such as within primary (e.g., grit chambers) and secondary (e.g., aeration tanks) treatment processes. Through bubble bursting wastewater treatment plants can be one important sources of bioaerosol in the atmosphere and also pose occupational health hazard to the workers and communities near waste water treatment plants. The objective of this study was to quantify bioaerosol contributions from wastewater treatment plants by analyzing samples from a grit chamber and aeration tank at a wastewater treatment plant. Samples were processed for RNA quantification, targeted qPCR, and genome sequencing. Levels of RNA recovered from aerosol sampling ranged from 2.6 to 9.8 ng/µL. Targeted quantitative PCR found levels of the human dietary virus pepper mild mottle virus (PMMoV) at levels that ranged from 3.8×10^5 to 1.2×10^6 genomic copies (gc) per cubic meter of air. The virus that causes COVID-19, SARS-CoV-2, was observed at near detection limit levels (0 to 587 gc/m^3) for samples that recovered higher levels of RNA. Current efforts are focusing on increasing RNA recoveries in efforts to improve the sensitivity of measurements to aerosolized microbes from wastewater.

6BA.8

Bioaerosol Identification and Monitoring in Ireland. DAVID O'CONNOR, Emma Markey, Jerry Clancy, Moises Martinez-Bracero, *Dublin City University*

With a heightened awareness surrounding biologically derived aerosols in recent years, work has been carried out to examine whether the traditional monitoring systems for bioaerosol monitoring can be modernised or replaced with newer real-time online devices.

Traditional instruments currently in use include the Hirst volumetric sampler; a device that has seen little adaption in the 70 years since its inception (Hirst, 1952). Because of its near universal adoption, and its standardised build, bioaerosol monitoring studies across the world have been easily comparable and contrastable.

The Hirst device, however, has major drawbacks, primarily the laborious and time-consuming collection and analysis, rendering it unusable as a real-time or near-real-time monitor. The contemporary candidate chosen for this comparative campaign was the Waveband Integrated Bioaerosol Sensor (WIBS). The WIBS instrument records the shape, size and fluorescence intensity of each particle.

In this campaign, the devices were co-located on a rooftop in the centre of Dublin, Ireland, where both devices continuously recorded air samples between August to September 2019. All information from both devices was collected and collated for data analysis. Meteorological readings and readings from pollution sensors were also available to the project, and these datasets were incorporated to aid the identification and categorisation pollen and fungal species present in the urban environment. Previous studies have made similar efforts to identify and analyse bioaerosols.

Data analysis involved the completion of a set of Multiple Linear Regression analyses, in which a combination of the significant WIBS, meteorological, and pollution parameters were plotted against known bioaerosol outputs (data from the Hirst device). Incorporating such parameters into such an analysis led to good correlation between the two instruments.

Wind direction analysis was also undertaken to understand the sources of the bioaerosol and anthropogenic species in the environment.

6CA.1

Soot Restructuring and Compaction: Mechanisms and Resulting Effective Density. JOEL CORBIN, Timothy Sipkens, Robin Modini, Martin Gysel, *National Research Council Canada*

Recent work has identified the specific mechanisms by which soot restructuring causes compaction (Corbin et al., 2023). That work alternated between solid and liquid coatings to demonstrate that compaction was caused by both condensation and evaporation. Based on a review of dozens of other studies, in both the aerosol and surface-science fields, that work also identified specific mechanisms of compaction: capillary compaction (at junctures between soot spherules), nanodroplet activation (following heterogeneous nucleation) and droplet-evaporation compaction (occurring during evaporation, rather than condensation). The work of Corbin et al. (2023) discussed the implications of these mechanisms for climate and health in detail but did not evaluate the quantitative impacts of these mechanisms on the physical properties of soot.

Here, we quantitatively evaluate data from published studies of soot compaction. We focus on mobility data, with the goal of determining the range of effective densities that may be observed for soot. We also focus on cases of “complete” compaction, which we define as data from studies that show that the addition of more coating material did not cause more compaction. This constraint allows an apples-to-apples comparison to be made between studies. We find that the variability in the available data sets of complete compaction is largely explained by variation in primary particle diameter (and therefore number). Additional variability is due to two apparently unique compaction mechanisms. Importantly, the data show that commonly cited sources of uncertainty, such as surface tension and viscosity, are minor. We summarize these conclusions in terms of the resulting uncertainty in the effective density of compacted soot.

6CA.2

Mechanical Properties of Bare and Coated Soot Aggregates. ALEXEI KHALIZOV, Ali Hasani, *New Jersey Institute of Technology*

Soot, a product of incomplete combustion of fossil fuels, is a global warming agent and an air pollutant. The environmental effects of soot particles depend on their morphology. Freshly released soot particles are fractal aggregates made of spheroidal monomers, but in atmospheric samples collected away from emission sources they often appear collapsed. A body of work has concluded that the collapse is caused by liquid menisci forming by vapor condensation on soot aggregates. The menisci create forces that result in breakage of the connections between the soot monomers, leading to rearrangement of the monomers to a more compact configuration.

To gain better understanding of the mechanistic details of soot aggregate restructuring, we used atomic force microscopy (AFM) to perform force-displacement measurements on bare, coated, and coated-denuded soot aggregates to determine their mechanical properties. The force curve was determined by measuring the deflection of the cantilever as it approached the particle and was retracted from the particle. Peaks observed in the distributions of forces for soot aggregates can be related to the processes that occur during aggregate stretching and mechanical failure, such as the unfolding of the monomer chain and the cleavage of the weakest connection between monomers. We found that these forces were significantly affected in the presence of a condensate or after a condensation-denuding cycle. We will discuss how these results will be used for the parameterization of a physical model for soot restructuring.

6CA.3

Pore Structure Dynamics of Carbonaceous Particles by Surface and Internal Oxidation. GEORGIOS A. KELESIDIS, Patrizia Crepaldi, Sotiris Pratsinis, *Rutgers, The State University of New Jersey*

The dynamics and impact of internal and surface oxidation on carbon particle (CP) pore structure are elucidated by lattice Monte Carlo (LMC) simulations and compared to experimental data from the literature (doi.org/10.1016/j.carbon.2022.06.020). The fractal-like pore structure or network of unoxidized or as-prepared CPs is determined by diffusion limited aggregation and validated with those measured for carbon blacks and soot. At high temperatures (i.e. 800 °C and above), surface oxidation reduces the CP diameter, d_p, without affecting its internal structure. So, the evolution of CP mass, dp and specific surface area, *SSA*, closely follows the classic shrinking particle model (doi.org/10.1016/j.combustflame.2019.08.001). At low temperatures (550 °C), internal oxidation dominates, compacting the CP fractal-like pore network. This triples the CP *SSA* up at 75 % conversion. In the presence of a non-reactive graphitic shell though, internal oxidation stops after the reactive and largely amorphous CP core is consumed leveling off its *SSA* at large conversions (> 50 %). Accounting for the realistic core-shell pore structure of CPs during internal and surface oxidation nicely explains several measurements of soot and carbon black *SSA*, for the first time to the best of our knowledge. So the LMC-derived oxidation dynamics of CPs presented here can be used to assist the design of highly porous carbon black grades from first principles, as well as the mitigation of soot emissions by enhancing their oxidation in the exhaust of combustion engines.

6CA.4

Multiple Charging Effects on the CCN Activity of Black Carbon Particles. OGOCHUKWU ENEKWIZU, Ernie R. Lewis, Arthur J. Sedlacek, *Brookhaven National Laboratory*

The interactions of black carbon (BC)-containing particles with water vapor in the atmosphere are of interest because they can influence cloud formation in addition to influencing BC optical properties, and BC lifetimes through removal by scavenging and precipitation. Accurate measurements of hygroscopicity and cloud condensation nuclei (CCN) activity are needed given the positive forcing impacts of BC on climate. Measurements of hygroscopicity of BC-containing particles are typically conducted on particles selected only by their mobility with a differential mobility analyzer (DMA). However, a single DMA system also transmits larger particles, with multiple charges, that have the same mobility as the singly-charged particles. These larger particles will activate at lower supersaturations than the singly-charged particles, affecting measurements and resulting in overestimation of CCN activity. In this study, we combine a DMA with a centrifugal particle mass analyzer (CPMA) to select particles by both mobility and mass, thus resulting in only singly-charged particles. We demonstrate the use of the DMA-CPMA system in resolving biases caused by multiply charged particles in the CCN activation measurements of different BC surrogate particles with mobility diameters ranging from 100 to 300 nm. Additionally, we determine the hygroscopicity parameter (κ) of the BC surrogates. We find that multiply charged particles result in an overestimation of κ by 12 to 75 %, depending on the particle mobility diameter and composition of the BC surrogate. Our results also show that the effect of multiple charging on the CCN activity of the BC particles is strongly influenced by morphology dispersion, i.e., variability in morphology of particles with the same mobility and mass that results in variability in other properties such as CCN activity. Our findings demonstrate that use of particles selected by mobility alone will not lead to accurate results for the CCN activation and hygroscopicity of BC-containing particles.

6CA.5

Modeling of Joint Capillary Condensation of Trace Chemicals and Water on Fractal Soot Aggregates.

ELLA IVANOVA, Ali Hasani, Egor Demidov, Gennady Gor, Alexei Khalizov, *New Jersey Institute of Technology*

Soot from combustion is an effective light absorber that contributes significantly to direct climate forcing. It is also an air pollutant. Soot particles are branched fractal aggregates of spherical primary carbon particles (monomers). The negative impacts of soot on climate and human health depend on the morphology of soot aggregates. Experiments show that the condensation of vapors on fractal aggregates often causes their restructuring into compact globules. Furthermore, it was shown that even a small amount of condensate could induce restructuring if the coating material is located in the gap between monomers [1].

This work uses a numerical model to predict the joint capillary condensation of trace gas atmospheric chemicals and water on the fractal soot surface, as observed in the experiments, where a less than 3% mass fraction of water-soluble chemicals promoted aggregate collapse after humidification to 85% relative humidity In the model, as in an experiment, we use a two-step approach. First, we start by exposing the aggregate to the sub-saturated vapors of several individual chemicals using a kinetic condensation model [1, 2]. Then, we consider condensation of water vapor as a function of increasing humidity based on a thermodynamic model. Initially, the soot surface is hydrophobic; however, after exposure to hydrophilic chemicals, capillary water condensation becomes possible. The outcome depends strongly on the contact angle and shape of the meniscus of the condensate. The model results are in agreement with the experiments and confirm that even a small amount of water-soluble chemicals promote the condensation of water with following soot restructuring.

[1] Chen, Chao, et al. "Single parameter for predicting the morphology of atmospheric black carbon." Environmental science & technology 52.24 (2018): 14169-14179
[2] Ivanova, Ella et al. "Kinetic model for competitive condensation of vapor between concave and convex surfaces in a soot aggregate." Aerosol Science and Technology 55.3 (2020): 302-315.

6CA.6

Characterizations of Black Carbon Aerosols from Southeast U.S. Prescribed Fires and Western U.S. Wildfires.

ANDREW METCALF, Dongli Wang, *Clemson University*

Biomass burning from prescribed fires and wildfires are two important sources of carbonaceous aerosol in the atmosphere. Although the western U.S. receives noteworthy publicity for the wildfires which occur there almost every year, the southeastern U.S. actually has far more prescribed fires. Such fires have a significant impact on air quality and local visibility. However, field measurements of aerosol emissions from small, prescribed fires are relatively sparse. Black carbon (BC) is one of the important aerosol emissions from open biomass burning, affecting air quality and human health on regional scale. BC is also an efficient light-absorbing aerosol component and thus affects radiative transfer in the atmosphere. Optical properties are critical parameters determining the impacts of aerosol emissions on climate and are highly dependent on aerosol composition.

In this presentation, BC aerosol emissions from prescribed fires in the southeast U.S., from both historical and recent measurements, are compared to emissions from wildfires which predominantly occur in the western U.S. A scanning electrical mobility spectrometer (SEMS) is used to measure the total submicron aerosol size distributions, and a Single Particle Soot Photometer (SP2) is employed as the primary measurement of BC aerosol number and mass mixing ratios, mass and size distributions, and number fractions of coated and uncoated BC-containing aerosol particles. Measurements of western wildfires were conducted on an aircraft campaign, while measurements of southeastern prescribed fires were ground-based. Studying the difference in these two emission sources will provide information for emission inventories to better predict the impact on air quality and the climate system from BC aerosol.

6CA.7

Mapping Out the Absorption of Soot as a Function of Particle Mass Using CERMS and Laser-Induced Incandescence. RYM MEHRI, Joel Corbin, Timothy Sipkens, Fengshan Liu, Mark Johnson, Gregory Smallwood, *National Research Council Canada*

Soot has significant implications for health and the environment. Accurate measurement of soot light absorption is necessary to further understand its environmental impact and improve characterization techniques. The optical properties of soot (absorption and scattering) are often used to determine mass concentrations.

The centrifugal particle mass analyzer-electrometer reference mass system (CERMS) can be used to determine the mass of particulate in an aerosol stream. CERMS is composed of 1) a unipolar diffusion aerosol charger (UDAC) that uses a corona discharge to charge the particles positively or negatively, 2) a centrifugal particle mass analyzer (CPMA) to classify the particles based on their mass/charge ratio and 3) an aerosol electrometer to measure the charge concentration. The particle mass concentration can be determined based on the number of charged particles that reach the electrometer and the mass to charge ratio. When used with different mass instruments, CERMS can be used as a calibration system or to measure mass absorption cross-section (MAC) or absorption function E(m) based on the average particle mass. Previous studies have shown size dependence of soot MACs. The soot E(m), which is proportional to the MAC, is the optical parameter used in laser-induced incandescence (LII) instrument. Large variability has been reported for E(m), including how it may change with soot maturity and wavelength. In this study, we obtained a range of E(m) for soot emitted from a helicopter gas turbine engine by coupling CERMS with an LII. Measurements are supplemented with a scanning mobility particle sizer (SMPS) to provide size distributions of the classified particles. Through the measured E(m) as a function of particle size, MAC can be calculated and compared to data provided in the literature. This will help in further understanding soot's light absorption and provide insights on the LII response as a function of particle size.

6CA.8

Radiative Forcing of Black Carbon Containing Particles from Tethered Balloon Vertical Profiles at the Southern Great Plains Atmospheric Radiation Measurement Site. SUSAN MATHAI, Nurun Nahar Lata, Zezhen Cheng, Fan Mei, Darielle Dexheimer, Swarup China, Claudio Mazzoleni, *Michigan Technological University*

Black carbon (BC) containing particles affect climate directly by efficiently absorbing solar radiation and indirectly by serving as cloud and ice nuclei as well as by altering surface albedo. However, the light-absorption properties of BC containing particles are highly variable with respect to altitude due to changes in concentrations, physiochemical properties, morphology, and mixing state, leading to large uncertainties in radiative forcing calculation. In this study, we focus on the vertical distribution of BC containing particles and its single particle mixing state at the Atmospheric Radiation Measurement (ARM) Southern Great Plains (SGP) site. Data and samples were collected during February and April 2022 by deploying instruments onboard an ARM tethered balloon system (TBS). We deployed two micro-aethalometers (AE51 and MA200) to monitor the BC concentration at different altitudes along with a condensation particle counter (CPC) for total particle concentration measurement, and a Portable Optical Particle Spectrometer (POPS, Handix scientific) to monitor the size distribution of the particles. We also deployed an automated Size and Time-resolved Aerosol Collector (STAC) to collect particles at different altitudes. Single particle measurements using multi-modal microscopy and spectroscopy techniques show abundance of carbonaceous and sulfate particles during different events. We use the size distribution and particle concentration measurements from POPS and CPC and the MA200 to estimate the scattering and absorption coefficients at different altitudes. Then we calculated the radiative forcing using the Santa Barbara DISORT Atmospheric Radiative Transfer (SBDART) model. This study will improve our understanding of radiative forcing from BC particles and their mixing states at different altitudes.

6CC.1

Black Carbon Aerosols Properties for Remote Sensing and Radiative Forcing Applications. HANS MOOSMÜLLER, Greg Schuster, Eduard Chemyakin, Snorre Stamnes, Jacek Chowdhary, *Desert Research Institute*

Material and morphological properties of light absorbing particles in the atmosphere determine their single scattering albedo, asymmetry parameter, and direct radiative forcing, thereby affecting climate change predictions and mitigation. A quantitative understanding of aerosol optical properties is also needed for their global quantification through satellite and ground-based remote sensing. The dominant light absorbing aerosol is black carbon (BC) that has non-spherical, fractal-like shapes that complicate the determination of its optical properties. Here we discuss the basic material and morphological properties of BC aerosols as needed to understand, measure, and calculate their optical properties with a focus on recent progress and remaining gaps in obtaining and using these properties.

For BC aerosols, the complex refractive index outside of the visible spectrum is still poorly constrained, probability distribution functions for parameters of fractal-like shape models and their evolution during atmospheric aging are inadequately defined, and complex refractive indices of atmospheric BC coatings are also insufficiently known. In addition, DDA calculations for coated fractal-like chain aggregates, as needed for modeling the optical properties of atmospheric BC aerosols, are computationally very costly. While such calculations for coated BC particles have made great progress (Liu et al., 2022), extension to size-averaged ensemble calculations with more random realization of morphology types are still needed. These knowledge gaps greatly limit BC radiative transfer evaluation and satellite retrievals. Here, we further outline these knowledge gaps and discuss research efforts needed to fill them.

This work has been supported in part by NSF grant No. OIA-2148788 and NASA ROSES grant 80NSSC20M0205 (PACE SAT Project: PACE UV ROAD).

Reference: Liu, L., G. L. Schuster, H. Moosmüller, S. Stamnes, B. Cairns, and J. Chowdhary (2022). Optical Properties of Morphologically Complex Black Carbon Aerosols: Effects of Coatings. J. Quant. Spectrosc. Radiat. Transfer, 281, 108080 (11 pages), doi.org/ 10.1016/j.jqsrt.2022.108080.

6CC.2

Determination of the instantaneous aerosol-radiation interactions (direct effects) using High Spectral Resolution Lidar (HSRL)-derived aerosol type-specific optical properties and CATCH algorithm. BETHANY SUTHERLAND, Nicholas Meskhidze, *NC State University*

As aerosols remain the largest source of uncertainty in climate projections, utilizing aerosol type-specific values for the single scattering albedo (*SSA*) and asymmetry parameter (*g*) along with vertically-resolved HSRL retrievals of aerosol types (i.e. smoke, urban, dust, marine, etc.) presents a promising opportunity to lower uncertainty in aerosol-radiation interactions. The Creating Aerosol Types from Chemistry (CATCH) algorithm has been shown to produce aerosol types analogous to HSRL-retrieved types based on GEOS-Chem simulated aerosol microphysics over the North American domain during the SABOR and DISCOVER-AQ campaign periods (Dawson et al., 2017). It was also shown that average (effective) values of CATCH-derived *SSA* and *g* are generally characteristic for a given type and the variabilities in calculated type-specific values of *SSA* and *g* are within the range reported in the literature. As spatiotemporal distributions of HSRL-retrieved aerosol types are not currently available, the CATCH-derived types are used to calculate TOA radiative fluxes over the North American domain during the two campaigns. Radiative transfer calculations are performed using the RRTMG radiative transfer model, which has been implemented online in GEOS-Chem. To assess the uncertainty in the estimated direct effects due to implementing type-specific aerosol optical properties, TOA radiative fluxes with type-specific values of *SSA* and *g* as inputs in RRTMG are compared to fluxes calculated using the GEOS-Chem simulations for the same period. To estimate the uncertainty in prescribed *SSA* and *g* values for given aerosol types over the entire North American domain, the derived ranges in type-specific values for *SSA* and *g* are compared with AERONET-retrieved *SSA* and *g* on days when vertical profiles were dominated by a single aerosol type.

6CC.3

Chemical Characterization and Single-Particle Measurements of Soot Aerosol in Houston: Insights into Sources, Processes, and Black Carbon Mixing States.

RYAN FARLEY, James E. Lee, Laura-Helena Rivellini, Alex K.Y. Lee, Rachael Dal Porto, Kyle Gorkowski, Abu Sayeed Md Shawon, Katherine Benedict, Allison Aiken, Manvendra Dubey, Christopher Cappa, Qi Zhang, *University of California, Davis*

The effects of soot aerosol on the Earth's climate system are highly influenced by the mixing state of black carbon aerosol and its coating materials. To shed light on these relationships, we employed a high-resolution soot particle aerosol mass spectrometer (SP-AMS) to measure the size-resolved chemical composition and the single particle mixing state of submicron soot aerosol in Houston, TX during the TRACER campaign in the summer of 2022. The SP-AMS was operated to selectively measure only refractory black carbon (rBC) and associated coating material. The average rBC concentration was 62 ± 116 ng m-3 and the BC coatings primarily consisted of organics (63%) and sulfate (26%). Positive matrix factorization analysis (ensemble particle measurements) and K-means clustering (single particle measurements) were used to understand the sources and atmospheric processing pathways of the rBC containing aerosol. Soot aerosol during TRACER had diverse sources including an oxidized organic aerosol (OOA) factor related to processed primary organic aerosol, an inorganic sulfate factor, an oxidized rBC factor and a mixed mineral dust/biomass burning factor with significant contribution from K+. Additionally, the single particle clustering allows us to further differentiate soot aerosol populations mixed with OA of various degrees of oxidation. The single particle measurements highlight the large variation in BC coating thickness with coating mass to black carbon mass ratios ranging from 0.1 to 100 for individual particles. The average mixing state index (χ) was 47 ± 12%, indicating that BC cannot be described as either fully internally or externally mixed. Higher χ values were measured during the day than at night indicating the importance of photochemical processing or regional transport of atmospherically processed aerosol. Our study provides valuable insights into the mixing state of BC aerosol and its impact on the atmosphere.

6CC.4

Changing Climate and the Toxicity of Wildfire-derived Brown Carbon Particles: A Literature Synthesis and Science Assessment for Evaluating Potential Human Health Impacts.

BROOKE L. HEMMING, Anne E. Barkley, *U.S. Environmental Protection Agency*

The changing intensity, and scale of wildfire is a symptom of climate change with significant smoke-related impacts on public health and downwind ecosystems. On-going climate change will continue altering these patterns while at the same time affecting the variables that determine smoke toxicity and its impacts. Among the climate-sensitive variables impacting smoke chemistry and toxicity are those affecting the primary carbon content (both mass and chemical form) of smoke particles, the nature and rates of in-plume photochemical oxidation processes, and the altitudes and transit periods of smoke plumes. Climate impacts the carbonaceous content of primary smoke emissions by altering biomass species distributions and the form in which fuels are present in fire-prone ecosystems, as well altering meteorological patterns that control fuel moisture and burning conditions (i.e., drought versus extreme precipitation cycles, the occurrence of fire weather conditions influencing hot versus smoldering combustion conditions). Climate also influences the entrainment of soil and dust that can change mix of reactive species in a smoke plume.

The formation and photochemistry of atmospheric brown carbon (BrC) is a major subject of interest given its effect on radiative forcing of the climate system. The photochemical reactions studied and proposed as mechanisms for combustion-produced and photochemically formed brown carbon lead to particle-bound species that have clear implications for the health of exposed human populations. This presentation will provide an overview of the theoretical climate --> wildfire BrC -->human health process based on a synthesis of available scientific literature and suggestions for additional research that can inform our understanding of the process. This work is a component of an EPA assessment intended to improve understanding of the potential influence of future climate change on wildfire smoke toxicity for humans and downwind ecosystems, in support of the development effective strategies for climate-adaptive public health and ecosystems protection strategies.

6CC.5

Occurrence and Properties of Wildfire Aerosol Plumes Measured at the High-Altitude Station Jungfraujoch.

BENJAMIN BREM, Nora Nowak, Nicolas Bukowiecki, Martine Collaud Coen, Martin Steinbacher, Martin Vollmer, Stephan Henne, Reimann Stefan, Martin Gysel, *Paul Scherrer Institute*

Our history has been a story of how we and fire have co-evolved. The same holds for our future. Wildfires are often not “wild” and can be linked to human activity. Hence, some claim that we are living in the “Pyrocene” [1]. Large-scale biomass burning events emit substantial amounts of primary particulate matter (PM) and gaseous secondary PM precursors. Fractions of these emissions can be injected into the free troposphere where they can be transported over long distances and exhibit a stronger radiative forcing efficiency than at ground level [2]. Large light absorbing carbon concentrations in the free troposphere can also alter the vertical temperature profile, leading to a stratification of the atmosphere below with consequences for clouds and precipitation [3].

This work characterizes the optical and microphysical properties of wildfire plumes transported to the Jungfraujoch (JFJ) Station (3571m a.s.l.). More than thirty wildfire plumes were identified from hourly averaged data for the period between January 2015 and December 2020 using a data screening procedure based on gaseous data and backtrajectories. Plume occurrence frequency, origins and plume optical and chemical properties will be presented at the meeting. In addition, ongoing work investigates changes in plume optical properties with atmospheric processing.

[1] Pyne, S., (2018), J. Fire, 1, 44-49.
[2] Val Martin et al., (2006), Journal of Geophysical Research Atmospheres, 111, 456- 462.
[3] Ban-Weiss et al., (2012), Clim Dyn 38, 897–911.

6CC.6

The Effects of Acid-Catalyzed Multiphase Chemistry on the Hygroscopicity and Deposition Ice Nucleation of Complex Inorganic-Organic Mixed Aerosols.

Sining Niu, Christopher Rapp, Yeaseul Kim, Zezhen Cheng, Gregory W. Vandergrift, Jason Surratt, Gourihar Kulkarni, Daniel Cziczo, Alla Zelenyuk, Swarup China, YUE ZHANG, *Texas A&M University*

Aerosol-cloud interactions are one of the largest uncertainties in estimating the radiative forcing and predicting future climate. The physicochemical properties of aerosols can significantly alter their cloud condensation and ice nucleation properties. This study aims to bridge the scientific gap by investigating the impacts of multiphase reactions on the chemical composition, phase state, mixing state, and morphology of the particles, and examining how the modification of the physicochemical properties would jointly affect the cloud condensation and ice nucleation activities.

The SOAs derived from four BVOCs (α-pinene, limonene, β-caryophyllene, and isoprene) are generated from a potential aerosol mass (PAM) reactor, with both neutral ammonium sulfate (AS) and acidic ammonium bisulfate (ABS) seed particles so as to distinguish between ocndensation and multiphase reactions. Both online and offline techniques are utilized to monitor the change of the chemical composition, specifically, the formation of OS through multiphase oxidation. Filter samples are collected, and the concentration and chemical composition of OS is determined by high resolution Aerosol Mass Spectrometer and Nanospray Desorption Electrospray Ionization coupled with Orbitrap mass spectrometer. The SOAs are also collected onto the TEM grids with their morphology and phase state being analyzed with a Scanning Electron Microscope. The cloud condensation and ice nucleation (IN) activities of the SOAs undergoing multiphase reactions are measured by the Cloud Condensation Nucleus (CCN) Counter and the Continuous Flow Diffusion Chamber (CFDC) in real-time to derive hygroscopicity parameter κ and ice nucleation onset RH, respectively.

Our results show that the hygroscopicity of the OS containing BVOC-derived SOA drastically decreased compared with the inorganic ABS seed particles, indicating a reduction of CCN and change of the IN activity during the multiphase reactions.

6CC.7

Microplastics as Ice Nucleating Particles in the Atmosphere.

HEIDI L. BUSSE, Devaka Ariyasena, Miriam Freedman, *The Pennsylvania State University*

The role that microplastics act as ice nucleating particles in the atmosphere is unknown. Studies have indicated that microplastics have sufficient atmospheric lifetimes and transport to warrant studies into their impact on these climate systems. Aerosol particles, including microplastics, can impact the global radiation balance through direct or indirect pathways of interaction with incoming and outgoing radiation. One indirect pathway is ice nucleation, by which aerosol particles impact the properties of clouds. Here, drop freezing assays performed in an environmental chamber were used to investigate the immersion freezing of microplastics. Microplastics studied included three compositions (i.e., polypropylene, polyethylene, and poly(vinyl chloride)) and ranged in size from 25 to 150 µm. The immersion freezing across size ranges of the plastics found no size dependence on the ice nucleation of the samples. Additionally, microplastics were exposed to ozone, ultraviolet light, ammonium sulfate, and sulfuric acid to mimic aging of the plastics in the environment. Investigation into immersion freezing of unaged and aged microplastics found that exposure to ultraviolet light and ozone led to a general decrease in the freezing temperature while aging via ammonium sulfate and sulfuric generally increased the freezing temperature. Overall, a better understanding of the ways in which microplastics may act as ice nucleating particles and what factors may contribute to an enhancement or suppression of this ice nucleating ability allows for the improvement of atmospheric models and a better understanding of our complex atmospheric system.

6DI.1

Elemental Characterization of Ambient Particulate Matter for a Globally Distributed Monitoring Network: Methodology and Implications. XUAN LIU, Randall Martin, Jay R. Turner, *Washington University in St. Louis*

Global ground-level measurements of elements in ambient particulate matter (PM) can provide valuable information to understand emission sources of dust and trace elements, assess their health impacts, and improve atmospheric models. We use Energy-dispersive X-ray Fluorescence to characterize the elemental composition of PM collected from 24 globally distributed sites in the Surface PARTiculate mAtter Network (SPARTAN) over 2018−2022. Consistent protocols are applied to collect all samples and analyze them at one central laboratory which ensures the comparability of data across sites around the world. Reference materials that mimic filter material and mass loadings of typical PM samples are applied to calibrate the instrument. Routine quality control measures are implemented to monitor instrument stability and acceptance testing is conducted to ensure filter quality. Background levels from both lab and field are considered to calculate method detection limits. Additive and proportional uncertainties are estimated to provide overall measurement uncertainties. Long-term concentrations of dust and trace element oxides (TEO) are determined from the elemental dataset for SPARTAN sites. In addition to sites in arid regions, high dust concentration (6 µg/m^3) in PM2.5 is also observed in Dhaka (Bangladesh) with a high TEO level (6 µg/m^3). High carcinogenic risk (>1 cancer case per 100,000 adults) from airborne arsenic is observed in Dhaka, Kanpur (India), and Hanoi (Vietnam). Common emission sources including dust, traffic, and coal combustion are identified for these sites, with coal combustion likely the major arsenic source as indicated by principal component analyses.

6DI.2

Source Attribution of PM2.5 and Health Effects in Kinshasa, Democratic Republic of Congo. DANIEL WESTERVELT, Paulson Kasereka, Garima Raheja, Jean-Luc Balogije Selenge, Rodriguez Yombo Phaka, V. Faye McNeill, Guillaume Kiyombo Mbela, Marianthi-Anna Kioumourtzoglu, Joel Nkiama Konde, Jean-Pierre Mfuamba Mulumba, Djibi Buenimio, *Columbia University*

Estimates of air pollution mortality in sub-Saharan Africa are limited by a lack of surface observations of fine particulate matter (PM2.5). Despite being large metropolises, Kinshasa, Democratic Republic of the Congo (DRC), population 14.3 million, has had little attention towards air quality monitoring. In 2019, a 5-node PurpleAir network was deployed in the city. Calibrated annual average PM2.5 for 2019 in Kinshasa was estimated at 43.5 µg m^{-3}, more than 8 times higher than WHO Interim Target 1 of 5 µg m^{-3}. This initial study motivated additional instrumentation in Kinshasa, Congo as a whole, and neighboring Brazzaville. New deployments included a small Clarity Node-S network, a QuantAQ Modulair, and a reference method PM2.5 MetOne Beta Attenuation Monitor (BAM-1020). In addition, monitoring of gas-phase species, including NO2, O3, CO, CO2 is now underway. Here we present first results from this aggregated, multi-sensor, multi-species network in the Congo. We first conduct a sensor intercomparison, comparing the performance of three different popular sensor brands (PurpleAir, Clarity, and QuantAQ) evaluated against the reference BAM-1020. Initial findings suggest that QuantAQ PM2.5 is most correlated and least biased compared to the reference, followed by PurpleAir and by Clarity. We also use our co-location to develop a simple correction factor using both Multiple Linear Regression and Gaussian Mixture Regression, a probabilistic method that has been shown to perform better than commonly used methods in other African cities. We also leverage on-site gaseous pollutant concentrations, particle size distribution data from an optical particle counter, and anemometer data to draw some initial conclusions about sources of PM2.5 in Kinshasa. In particular, we link factors resolved from a nonnegative matrix factorization method using the gaseous species and particle bin concentrations to particular source profiles (e.g. combustion). We find a 3-factor solution that points to a CO-dominated, larger particle source potentially indicative of secondary particles from local combustion, along with a particle-dominated source indicative of primary particles from combustion, and a regional biomass burning source. We leverage wind speed and direction data as well as diurnal cycles to help discern sources. Finally, we use respiratory hospitalization data from Kinshasa to characterize exposure-resposne curves between PM pollution and respiratory outcomes using outcome-specific Poisson mixed models in an estimation framework that allows for overdispersion and include random intercepts to account for within-zone outcome correlation over time. Our results highlight the need for clean air solutions implementation in the Congo.

6DI.3

Determinants of Air Pollution Exposures in Urban Charcoal-Using Households in Sub-Saharan Africa. STEPHANIE PARSONS, Joseph Pedit, Cheryl Weyant, Pamela Jagger, Andrew Grieshop, *North Carolina State University*

Cooking with solid fuels, such as wood and charcoal, is prevalent in sub-Saharan Africa and associated with high air pollution exposures. Interventions with cleaner fuels, such as LPG, have targeted these populations, but have often been unsuccessful due to fuel price and availability. While sub-Saharan Africa has rapidly urbanizing populations who often use charcoal, these populations are studied less than those in rural areas where wood use is prevalent. Urban exposures are complex because a wider variety of sources beyond cooking influence exposure. Here, we synthesize personal exposure measurements from three cities in sub-Saharan Africa and investigate the influence of cooking and other factors on exposure within and between sites. We collected household demographic information and carbon monoxide (CO) and particulate matter ($PM_{2.5}$) personal exposure of primary cooks in the following sites and time periods: Lilongwe, Malawi (2014, n=120); Gisenyi, Rwanda (2015-2020, n=2521); and Lusaka, Zambia (2019, 2021, n=662). We use diverse remote sensing and reanalysis data sets (e.g., MERRA-2, AIRS, VNP46A3) of ambient concentrations and meteorological parameters for each site to estimate the contribution of solid fuel use versus regional background to personal exposures. Generally, CO exposures increased and $PM_{2.5}$ exposures decreased with increased urbanicity. Season plays a crucial role in exposure: exposure was 50% lower in Zambia during the warm season compared to the cold, and $PM_{2.5}$ exposure in Rwanda differed significantly between seasons. We will compare distributions of site-specific exposures and ambient concentrations to determine to what extent regional background concentrations, versus community- or household-level determinants, contribute to variation in cooks' personal exposures.

6DI.4

Understanding Spatiotemporal Variability and Local Sources of Indoor and Outdoor PM2.5 across Urban and Rural Neighborhoods in New York State. Marco Eugene, SANCHITA PAUL, Farid Barak, Md. Aynul Bari, *University at Albany, SUNY*

While urban ambient air quality is routinely monitored in major U.S. cities, little attention has been paid to assess the quality of air in residential neighborhoods. In general, American adults typically spend two-third of their time indoors in residential environments. Different daily activities and sources within homes may contribute considerably to exposure to particles. The COVID-19 pandemic with home isolation and tendency to working from home drastically increased the daily indoor activities in recent years, leading to increased indoor air pollutants and associated risk to vulnerable population. This highlights the importance of monitoring indoor and near-field outdoor air quality across neighborhoods in New York State (NYS).

Due to cost and logistics required for reference-grade PM2.5 monitors and limitations for wide-spread deployment, the use of low-cost sensors have shown a great promise. We measured PM2.5 both indoors (living room) and outdoors (backyards) using low-cost PurpleAir sensors in selected neighborhoods in the NYS Capital Region and Hudson Valley communities. We deployed sensors in 4-5 homes/apartments of each neighborhood during winter and spring of the study period November 2021-May 2023 to collect data from at least 60 homes. We performed local calibration of outdoor PurpleAir sensor data by co-locating with a reference monitor at NYS Department of Environmental Conservation (DEC) site in Albany. Our preliminary data suggests that outdoor concentrations were significantly higher than indoors, indicating an influence of potential local sources (e.g., landfills, port emissions) at some communities. Indoor concentrations were also varied significantly across neighborhoods. Source directional analysis further confirmed the influence of known local sources on neighborhood air quality. Our findings will provide an improved understanding of community-specific particulate air pollution problems, can benefit the general people to improve their knowledge, increase awareness, and inform policy makers the need to reduce indoor and near-field outdoor air pollution.

6DI.5

From Source Characterization to Ambient Measurements to Dissemination: An Overview of the NAMaSTE Project in the Kathmandu Valley of Nepal. PETER F. DECARLO, Benjamin Werden, Michael R. Giordano, Erin Katz, Md. Robiul Islam, Thilina Jayarathne, Tianyi Li, Elizabeth Stone, Chelsea Stockwell, Ted Christian, Robert J. Yokelson, Eri Saikawa, Donald Blake, Simone Meinardi, Isobel Simpson, Arnico Panday, Prakash Bhave, Siva Praveen Puppala, Douglas Goetz, Sagar Adhikari, Rashmi Shrestha, *Johns Hopkins University*

The Nepal Ambient Monitoring and Source Testing Experiment (NAMaSTE) was a multi-institutional effort to characterize and quantify the various sources of air pollution in the Kathmandu Valley and Indo-Gangetic Plain of Nepal. In country collaborators at the International Center for Integrated Mountain Development (ICIMOD) were critical for the successful execution of this project. Beginning in 2015, aerosol and gas-phase emissions from common South Asian sources (e.g. brick kilns, trash burning, agricultural residue burning, cookstoves) were characterized using filter collection and offline analysis, online Aerosol Mass Spectrometry (AMS), and photo-acoustic spectroscopy. Gas-phase emissions were measured with a variety of instruments including FTIR, WAS, and CRDS. Source chemical and mass spectral profiles and emission factors were generated from this portion of the project. These were then utilized in regional models and with ambient measurements to quantify the source contributions to ambient aerosol both regionally and explicitly at 4 different locations in and adjacent to the Kathmandu Valley and covering a mix of socioeconomic areas within the agglomeration. Source apportionment studies of ambient particulate matter using AMS with positive matrix factorization and filter collection with chemical mass balance agreed well and showed source differences across the study sites. Although no single source was dominant at any of the sites trash burning, traffic, biomass burning, and dust are major concerns. Results from this multi-stage effort have been used by local partners in Nepal, and international agencies to identify strategies for improving air quality in Kathmandu and more broadly in South Asia.

6DI.6

Seasonal Variability of Indoor Air Pollutants and Their Effect on Health in Lucknow City- Metropolitan City (Capital of the Most Polluted State in the World).

ANAM TAUSHIBA, Rahila Rahman, Alfred Lawrence, *Integral University Lucknow, India*

The ubiquitous particulate matter has the potential to spontaneously bind to polycyclic aromatic hydrocarbons (PAHs) and regarded as a significant threat to the health of humans. The purpose of this study was to assess the concentration of airborne particulates of air pollution risks specifically women's health by determining three crucial parameters- inhalable particulates, microbiological contaminants (bacteria and fungi) load present in the air, and PAHs which are associated with PM2.5 in the air environment of Lucknow, India during summer and winter seasons in six distinct households located in various areas of the city throughout the summer season (April, May, and June) in 2022 and the winter season (November, December, and January) in 2022–2023. The study's primary focus is indoor air quality, and it begins with a questionnaire survey that was primarily carried out to determine how it affects women's health. Six houses from various microenvironments were chosen for indoor monitoring based on the survey results. The study's observation of the indoor particulate matter concentration trend revealed that most of the greatest concentrations are found in homes close to an industrial region. In the winter, the H4 and H6 had the average indoor PM2.5 concentrations, measuring 202.3 µg/m3 and 209.1 µg/m3 respectively, whereas, in the summer, the H5 and H6 had the highest indoor PM2.5 concentrations, measuring 142.1 µg/m3 and 167.0 µg/m3 respectively. Even though, the H5 PAH, with an average indoor concentration of 17.541ng/m3, had the highest average indoor concentration among PM2.5-associated PAHs. Also, women of all ages performed the LADD followed by the LLCR. Regarding microbial contaminants, high bacterial and fungal loads of 4980.21 CFU/m3 and 524.23 CFU/m3 in the month of June in the kitchen area were found in the summer due to high temperatures and greater humidity, which provided more nutrients for bacterial and fungal growth (due to a rise in the rate of biodegradation of food waste as well as leftovers). While in the same context, low bacterial and fungal loads were found in the winter. The results obtained from this research will represent the initial step towards giving better insight into the air quality in a variety of microenvironments. This would also help to gain an understanding of the negative effects of microbiological pollutants and provide a better basis for creating new regulations for prospective restrictions.
Keywords: Indoor air, Seasonal variation, LLCR, Passive method, Particulate matter, Health assessment.

6DI.7

EASIUR-HR: A Model to Evaluate Exposure Inequality Caused by Ground-Level Sources of Primary Fine Particulate Matter.

BRIAN GENTRY, Allen Robinson, Peter Adams, *Carnegie Mellon University*

People of color disproportionately bear the health impacts of air pollution, making air quality a critical environmental justice issue. However, quantitative analysis of the disproportionate impacts of emissions is rarely done due to a lack of suitable models. Our work develops a high-resolution reduced-complexity model (EASIUR-HR) to evaluate the disproportionate impacts of ground-level primary $PM_{2.5}$ emissions. Our approach combines a Gaussian plume model for near-source impacts of primary $PM_{2.5}$ with a previously developed reduced-complexity model, EASIUR, to predict primary $PM_{2.5}$ concentrations at a spatial resolution of 300 m across the contiguous United States. We find that low-resolution models underpredict important local spatial variation of air pollution exposure to primary $PM_{2.5}$ emissions, potentially underestimating the contribution of these emissions to national inequality in $PM_{2.5}$ exposure by more than a factor of 2. We apply EASIUR-HR to analyze the impacts of vehicle electrification on exposure disparities. While such a policy has small aggregate air quality impacts nationally, it reduces exposure disparity for race/ethnic minorities. Our high-resolution RCM for primary $PM_{2.5}$ emissions (EASIUR-HR) is a new, publicly available tool to assess inequality in air pollution exposure across the United States.

6DI.8

Black Carbon Measurements in Multiple Cities of Sub-Saharan Africa with Low Cost Image-Reflectance Method.

ABHISHEK ANAND, Albert Presto, Suryaprakash Kompalli, Eniola Ajiboye, Evelyne Toure, Julien Bahino, Sylvain Gnamien, *Carnegie Mellon University*

There is a lack of continuous monitoring of air pollutants in the Global South due to high cost of regulatory monitors. We have developed a low-cost method that utilizes reflected red light from particle deposits on filters to measure black carbon (BC). US embassies around the world use Beta Attenuation Monitors (BAMs) to measure $PM_{2.5}$. A BAM collects $PM_{2.5}$ on filter tapes every hour as spots and uses beta ray attenuation through each spot to measure hourly $PM_{2.5}$. We photograph particle spots on used filter tapes from these existing BAMs at US Embassies one at a time with a custom reference card and then apply an image processing algorithm on the photo to estimate BC concentration for that hour. BC estimates from BAM tapes were validated with elemental carbon at a US EPA’s Chemical Speciation Network site in Pittsburgh. The effective detection limit of the method is approximately 0.15 $\mu g.m^{-3}$ for 1-hr samples. We present 2 months (July-August 2020) of hourly BC concentrations for three cities in Sub-Saharan Africa, including Abidjan (Côte d’Ivoire), Addis Ababa (Ethiopia), and Accra (Ghana). The hourly BC data at the three sites show a clear diurnal pattern of BC with prominent peaks during the morning and evening rush hours on workdays. The average BC for the 2-month period at the Abidjan US embassy was 3.85 $\mu g.m^{-3}$ (weekdays: 3.33 $\mu g.m^{-3}$, weekend: 3.98 $\mu g.m^{-3}$). The hourly $PM_{2.5}$ concentrations collected by the Embassy showed a high correlation ($R^2 \sim 0.55$) with the estimated BC levels. The average BC to $PM_{2.5}$ fraction was estimated to be ~18% during weekdays which dropped to ~15% on weekends. The $PM_{2.5}$ composition data, thus acquired, can be crucial in identifying emission sources and help in effective policymaking.

6IA.1

Assessing the Influence of Humidity and Surface Reservoirs on Indoor Ammonia Dynamics at the CASA Experiment: A Modeling Study.

Marc Webb, Glenn Morrison, Stephen Zimmerman, Michael Link, Dustin Poppendieck, Marina Vance, Delphine K. Farmer, BARBARA TURPIN, *University of North Carolina at Chapel Hill*

Although indoor ammonia (NH_3) is an important contributor to the chemistry of indoor environments, its dynamics in residential environments are understudied. Because NH_3 is a water-soluble base, its behavior indoors is expected to be regulated by surface reservoirs, especially when humid. Surface interactions of NH_3 can alter building chemistry and human exposure to other indoor pollutants (e.g., gaseous acids and bases). As part of the Chemical Assessment of Surfaces and Air (CASA) experiment at the Net-Zero Energy Residential Test Facility (NZERTF), NH_3 was injected into a test house at 75% RH and 45% RH, and the concentration was monitored and modeled. NH_3 levels in room air were higher at 45% RH (avg: 239 ppb) than 75% RH (avg: 171 ppb). Maximum concentrations of NH_3 in house air reached 446 ppb at 75% RH and 695 ppb at 45% RH. Roughly ~80% (at 75% RH) and 70% (at 45% RH) of NH_3 was taken up by house reservoirs which indicated an RH effect associated with surface reservoirs. A mass balance model incorporating reversible surface sinks of RH-dependent volumes was developed to reproduce NH_3 measurements and provide fitted parameters for mass transport and surface reservoir volumes. Simulation of NH_3 dynamics required reversible surface sinks of RH-dependent volumes in ventilation ductwork and building materials. The effective “air” volumes of surface reservoirs increased with humidity and were predicted to be ~60,000 m^3 at 75% RH and ~40,000 m^3 at 45% RH. We estimate the liquid water content corresponding to the effective air volumes and influence on pH of sorbed water associated with NH_3 uptake.

6IA.2

Chemical Characteristics of Indoor Aerosol Particles and Surface Films. RACHEL O'BRIEN, Amy Hrdina, Cate Shirilla, Emily Heery, Kathryn Mayer, Dustin Poppendieck, Marina Vance, Delphine K. Farmer, *University of Michigan*

Indoor surfaces and the films on them play important roles in indoor air quality due to the high surface area to volume ratios in our homes. These films are formed from the deposition of aerosol particles and the sorption of semi-volatile organic compounds and are thus often complex mixtures of organic chemicals. The chemical complexity can expand even further after film formation as the chemicals in the mixture react and age on the surface. The composition of these films will play a role in their behavior indoors, so an improved understanding of the important chemical classes found in these films will help model predictions for partitioning of organic chemicals in indoor air. Important sources for chemicals in these films are cooking, cleaning, and aerosol particles from outdoors including wildfire smoke. Cooking can be a large source for semi-volatile and lower volatility organic compounds. Cleaning processes can generate aerosol particles and leave behind lower volatility material on indoor surfaces. Depending on the distance of the building from the fire, biomass burning organic aerosol particles (BBOA) can reach indoor spaces at different levels of aging. Here, we investigate the chemical composition of surface films formed on impermeable surfaces during different activities. Intact films formed on coupons that were deployed during the campaign are compared to films aged with ozone and higher relative humidity (RH). We also investigate the correlations between this composition, and the composition of size resolved aerosol particles collected at the NIST (National Institute of Standards and Technology) Net-Zero Energy Residential Test Facility during the CASA (Chemical Assessment of Surface and Air) field campaign.

6IA.3

Partitioning of Neutral Per- and Polyfluoroalkyl Substances (PFAS) Between Indoor Air and Various Reservoirs in North Carolina Homes: Results from the Indoor PFAS Assessment (IPA) Campaign. CLARA EICHLER, Naomi Chang, Jiaqi Zhou, Daniel Amparo, Elaine Cohen Hubal, Jason Surratt, Glenn Morrison, Barbara Turpin, *UNC-Chapel Hill*

Partitioning of per- and polyfluoroalkyl substances (PFAS) between indoor air and various reservoirs (e.g., settled dust, clothing) can prolong the residence time of PFAS indoors and contribute to PFAS exposure. During the UNC Indoor PFAS Assessment (IPA) Campaign, we collected samples of indoor gas phase, aerosols, settled dust, dust collected on heating and air conditioning (HAC) filters, pre-cleaned cotton cloth, and dryer lint in 10 homes in North Carolina over a period of nine months. We used gas chromatography-mass spectrometry (GC-MS, single quadrupole) for targeted analysis for nine neutral PFAS. Fluorotelomer alcohols (6:2, 8:2, and 10:2 FTOH) and perfluorooctane sulfonamidoethanols (MeFOSE and EtFOSE) were detected above method detection limits in all sample matrices, but concentration profiles differed among matrices. FTOHs are dominant in the gas phase and in settled dust, whereas FOSEs make up a larger fraction of the sum of measured neutral PFAS in the particle phase and in cloth. We used the data to derive partition coefficients for FTOHs and FOSEs. Shown as mean ±standard deviation, dust-air partition coefficients ($\log(K_{dust})$, unitless) ranged from 7.3±0.7 for 8:2 FTOH to 8.8±0.5 for EtFOSE, while cloth-air partition coefficients ($\log(K_{ca})$, unitless) ranged from 4.7±0.5 for 6:2 FTOH to 6.6±0.5 for EtFOSE, suggesting that per volume, PFAS partition to a larger extent to dust than to cloth. Partition coefficients are positively correlated with the octanol-air partition coefficient, $\log(K_{oa})$. We further investigated removal rates of neutral PFAS from homes via dust vacuuming, air conditioning systems, and dryer lint. The findings of this study will inform PFAS transport and exposure models and contribute to more comprehensive policies for PFAS exposure mitigation.

Disclaimer: The views expressed in this presentation are those of the authors and do not necessarily represent the views or policies of the U.S. EPA.

6IA.4

Impact of Preexisting Particles' Type and Concentration on Phase Partitioning of Indoor Semivolatile Organic Compounds (SVOCs).

SOHYEON JEON, Karolina Cysneiros de Carvalho, Jhao-Hong Chen, Brent Williams, *Washington University in St. Louis*

Semivolatile organic compounds (SVOCs) significantly contribute to both gas and particle phase air pollutants in indoor air. They have a substantial impact on indoor air quality and human health. Indoor gas-phase SVOCs can be released in large amounts from household items and chemical products, as well as from organic films that form on surfaces due to occupant activities such as cooking, cleaning, and smoking. Once released into the air, indoor gas-phase SVOCs can partition to particles that either infiltrate from the outdoor environment or originate indoors from human activities. Therefore, the properties of preexisting particles can significantly affect the gas-particle phase partitioning of SVOCs. In this study, we investigate the impact of preexisting particles' type (inorganic and organic) and concentration on the phase partitioning of various SVOCs (e.g., alkanes, phthalates, and PAHs) using a chamber. The study utilizes an aerosol mass spectrometer (AMS), thermal desorption aerosol gas chromatography (TAGs), and a scanning mobility particle sizer (SMPS) to monitor online bulk chemical composition, molecular-level chemical composition, and size distribution changes during the phase partitioning of SVOCs. The aim of the study is to provide insights into the factors that influence the fate and transport of indoor SVOCs in the presence of preexisting particles.

6IA.5

Disinfection Byproduct Formation via Multiphase Hypochlorous Acid Chemistry.

DOUGLAS COLLINS, Christopher Azzam, Risa Kanefsky, *Bucknell University*

The expansion of enhanced disinfection measures associated with the emerging understanding of airborne pathogens is currently leading to the proliferation of technologies to clean air and indoor spaces. Hypochlorous acid (HOCl) has been applied as a disinfectant via fogging but also can be released into the gas phase in substantial quantities during the use of chlorine bleach (sodium hypochlorite) solutions. HOCl is a potent oxidizer that reacts with a broad spectrum of chemical functional groups, lending to its strong disinfecting action. Prior studies have demonstrated that HOCl is removed from indoor air faster than the air exchange rate, and also demonstrated its multiphase reactivity with olefins and certain components known to exist in biomass burning particles. In the present study, we investigate the role of HOCl reactivity with catechol and methoxyphenols in the direct formation of hydroxylated polychlorinated biphenyls (OH-PCBs) and related compounds. It should be noted that OH-PCBs are known metabolites and oxidation products of PCBs and are thought to be of similar toxicity. Using liquid chromatography and advanced mass spectrometry, we demonstrate de novo formation of OH-PCBs upon uptake of gaseous HOCl to phenolic compounds applied to glass surfaces. Phenolic compounds are abundant in biomass burning aerosol, which is an increasingly important component of PM2.5 in populated environments in association with increasingly frequent wildfires. Hence the use of chlorine bleach or HOCl-based disinfectants in wildfire smoke-affected buildings could lead to the formation of toxic byproducts.

6IA.6

Modern Buildings Act as a Dynamic Source and Sink for Urban Air Pollutants. TIANREN WU, Antonios Tasoglou, Danielle Wagner, Jinglin Jiang, Heinz Huber, Philip Stevens, Nusrat Jung, Brandon E. Boor, *University of Cincinnati*

To meet indoor air quality and thermal comfort requirements for occupants, there is substantial air exchange between buildings and the urban atmosphere. In modern, mechanically ventilated buildings, HVAC systems drive air exchange between indoor and outdoor environments. The dynamic exchange of air between the two may influence urban air quality as buildings account for a large fraction of land use in cities. A field measurement campaign was conducted in an office to investigate how buildings affect the source and sink behavior of air pollutants. Direct measurements of volatile organic compounds (VOCs), ozone (O_3), and fine particulate matter ($PM_{2.5}$) were made throughout the HVAC system to determine net emission rates between the office and proximate urban air. The composition of urban air changed dramatically as it entered and circulated throughout the building due to interactions with various elements of the indoor environment. The office and its HVAC system were found to act as a net sink for O_3 and $PM_{2.5}$ for urban air, with mean net emission rates of -47.6 ± 31.3 and -2.3 ± 2.4 mg h^{-1}, respectively. This is primarily attributed to the enhanced ozone reactivity of indoor and occupant surfaces and in-duct aerosol filtration. Real-time VOC measurements via proton transfer reaction time-of-flight mass spectrometry revealed that the office serves as a net source of VOCs to urban air due to emissions from occupant activities and indoor surface reservoirs, with a mean net emission rate of 78.0 ± 73.5 mg h^{-1}. The per unit office area emission rates of isoprene and monoterpenes are comparable to those for forests and other vegetation areas. Changes in exhaust airflow rates, occupancy, and outdoor air concentrations caused significant temporal variations in the net emission rates. The HVAC system acts as an interface between indoor and outdoor atmospheres and strongly modulates the net mass transfer of pollutants between the two.

6IA.7

Assessing VOC Emission Rates from an Indoor Surface Using a Flux Chamber and PTR-MS. HAN N. HUYNH, Jenna Ditto, Jie Yu, Michael Link, Dustin Poppendieck, Delphine K. Farmer, Marina Vance, Jonathan Abbatt, *University of Toronto*

Chemical Assessment of Surfaces and Air (CASA) was a 6-week field campaign at the NIST Net-Zero Energy Residential Test FAcility (NZERTF) in March and April of 2022. The campaign focused on the behavior of chemical species in an unoccupied single-family home with continuous gas and aerosol measurements across a suite of instruments. Multiple experiments were conducted to examine the effects of different events (e.g., relative humidity changes, cooking, smoke injection) on indoor air, particles, and surfaces. Our team performed continuous ambient gas-phase measurements using a gas chromatograph (GC) inlet coupled to our Vocus PTR-ToF-MS. In addition, we set up a stainless-steel chamber for measuring gas fluxes from a painted surface inside the test facility. The sampled painted surface was located within two meters of the ambient indoor inlet of the GC-Vocus PTR-ToF-MS. The goal was to speciate and quantify volatile organic compounds (VOCs) fluxing from an indoor surface throughout the campaign, and to see how the VOC surface fluxes correlated with different perturbations in the house. We also determined how the molecular emission rates from the painted surface compared to the total emission rates in the house.

In general, we observed that the VOC surface fluxes throughout the campaign were not strongly impacted by perturbations to the test facility, indicating that the VOCs most likely came from the large surface reservoir underneath the painted surface instead of being introduced for the first time into the house during the CASA campaign. For all calibrated VOCs, we calculated comparable campaign-averaged VOC emission rates measured using the painted surface flux chamber measurements and calculated from the steady-state ambient measurements and total air change rate, when accounting for the total area of painted surfaces in the house. As well, during a zero-mechanical ventilation day, we were able to assess the whole house VOC emission rates using the ambient measurements. We get agreement within a few orders of magnitude between these three emission estimates, supporting the hypothesis that the house surfaces have equilibrated over a long period with VOCs constantly fluxing out at a relatively constant rate. Future experiments are required to assess whether VOC fluxes from a wide variety of types of indoor surface in other residential (e.g., occupied home) and commercial settings would yield similar results.

6IA.8

Investigating the Impacts of Building HVAC Systems on Aerosol Composition and Concentration. XINXIU TIAN, Bryan Berman, Bryan Cummings, Shannon Capps, Michael Waring, Peter F. DeCarlo, *Johns Hopkins University*

This work investigates how aerosols change in concentration and composition as they move through heating, ventilating, and air-conditioning (HVAC) systems. Without strong indoor emissions, outdoor-originated aerosols are the main contributor to indoor aerosols. Upon transport to the indoor environment through building HVAC systems, outdoor aerosol concentrations and chemical compositions are modified due to filtration and air conditioning (heating or cooling), especially when the indoor-outdoor temperature gradient is significant. Measurements were conducted in a modern HVAC system on the Johns Hopkins University Campus in Baltimore, MD. During the measurement period, the instrumentation sampled air from a valve switching system pulling from four different zones inside of the HVAC system: 1) return air, 2) mixed air where outdoor air is mixed with returned indoor air, 3) post filter and heating coil, and 4) supply - post cooling coil. We used a variety of instruments to measure the concentration and chemical composition of particulate matter and gases and T/RH. Instrumentation included 1) Soot Particle Aerosol Mass Spectrometer (SP-AMS), 2) scanning mobility particle sizer (SMPS), 3) proton transfer reaction – mass spectrometry (PTR-MS), 4) Three PICARRO gas concentration analyzers measuring CH_4, CO, CH_2O, CO_2, NH_3, and 5) Quant-AQ MODULAIR-PM. Results from this study demonstrate that the primary source of PM in the building originates outdoors. Positive Matrix Factorization on the organic component of the aerosol indicated 4 different sources. The identified factors changed in relative concentration as they passed through the HVAC system. The results also suggest that the filtration efficiency of the MERV filters in the HVAC varied for different species, and the installed filters did not achieve the expected filtration levels.

6SC.1

Automated Tandem Aerosol Classifier Experiments. JULIE PONGETTI, Timothy Sipkens, Morteza Kiasadegh, Jason S. Olfert, Jonathan Symonds, *Cambustion Ltd*

Aerosol classifiers are instruments which can select suspended particles based upon a particular physical characteristic over a narrow range of that characteristic. Examples include the Differential Mobility Analyzer (DMA), which selects particles by their electrical mobility (diameter); the Centrifugal Particle Mass Analyzer (CPMA) or Aerosol Particle Mass analyzer (APM), which select particles by their mass to charge ratio; and the Aerodynamic Aerosol Classifier (AAC), which selects particles by their relaxation time (or aerodynamic diameter). Often two of these classifiers will be used in series in so called “tandem” experiments to give yet more specific information about the nature of aerosol particles. For example, a tandem DMA (mobility diameter) and CPMA (mass) arrangement can measure the particle effective density. More generally, two-variable distributions (e.g. mass-mobility count distributions) can be built up by scanning both classifiers over a certain range of a two-dimensional matrix of setpoints and placing a particle counter downstream of the tandem pair. Such data can, for example, yield important insight into the transport properties of atmospheric or pharmaceutical aerosols

These experiments are however complicated to set up, and somewhat lengthy to execute. There is now an ongoing research collaboration between the University of Alberta, the National Research Council Canada, and Cambustion to automate such experiments using a variety of commercially available classifiers, by creating open-source Python software to control the classifiers and take readings from detectors, and to process (invert) the data to produce three-dimensional plots of the desired properties.

In this showcase we introduce the concept of tandem classifier experiments, and talk about the challenges. We also present the current state of the above automation project including a hands-on demonstration of part of such an experiment, augmented with video footage of a more complete experiment.

6SC.2

PTR-TOF: Real Time Analysis of Volatile and Condensed Organics on a Molecular Composition Level.

MARKUS MUELLER, Tobias Reinecke, Todd Rogers, *IONICON Analytik GmbH., Innsbruck, Austria*

IONICON is the leading producer of real-time trace gas analyzers based on Proton Transfer Reaction – Mass Spectrometry (PTR-MS). Without sample pre-treatment, our extremely sensitive PTR-TOF systems allow for quantitative detection of analytes on a molecular compositions composition level. Limits of detections are < 1 pptv for volatile organic compounds and, when the system is coupled to our genuine CHARON particle inlet, < 100 pg m^{-3} for condensed organics.

Our instruments are used in atmospheric and environmental research, indoor air analysis, engine emissions testing, food & flavor science, illicit substances detection, medical breath analysis and many more. Air quality monitoring networks and mobile laboratories benefit from our dedicated, robust trace VOC analyzers for mobile and field deployment. For this Application Showcase we will give a short introduction to PTR-MS, including basic operation principles and application examples in aerosol research.

With our PTR-TOF 4000 instrument we take the slogan of this session ‘Scientists doing Experiments drinking Coffee’ almost literally by performing a real-time measurement of coffee headspace. Similar to organic aerosol, coffee headspace is a very complex sample with a plethora of chemical information. The interpretation of such complex mass spectra is not trivial but with the new IONICON Data Analyzer (IDA) the audience is guided through all the needed data-analysis steps to get from raw data to quantitative time-series for compounds of interest.

Both experienced instrument developers and application scientists will be present during this showcase to engage with the audience, discuss experiences from measurement campaigns and answer all questions.

6SC.3

Hands-On Instrumentation Tutorial on Operating the Particles Plus Water Condensation Particle Counter (CPC) and Summarizing Collected Data.

SOTIRIOS PAPATHANASIOU, *Particles Plus*

This hands-on workshop provides participants with the opportunity to learn how to operate the Particles Plus Water Condensation Particle Counter (CPC). The workshop will provide an overview of CPC instrument architecture, as well as background on the technology and it’s applicability. The workshop will review lab-testing data as well as 3rd party evaluations for this instrument in order to provide details on expected accuracy and precision of CPC measurements. Participants will be guided through the installation, setup, usage and data collection for this instrument. By the end of the workshop, participants will be able to understand CPC operation and be capable of summarizing the collected data.

7AC.1

Exploring the Hygroscopic Growth, Phase and Chemistry of Light-Absorbing Aerosol using Single Particle Levitation.

JAMES F. DAVIES, Roya Bahreini, Malsha Amugoda, Prakriti Singh, Stephanie Salas, Erin Bowey, *University of California, Riverside*

Single particle levitation analysis of aerosol allows for samples to be manipulated in a contactless manner and exposed to environmental conditions that mimic the atmosphere over extended timescales. Using a linear quadrupole electrodynamic balance, we can confine and analyze multiple particles in a vertical stack, facilitating direct comparisons between particles of different composition and allowing for time-resolved chemical analysis by sequential sampling into a mass spectrometer.

Here, we report measurements on the hygroscopic growth properties for a range of phenolic and nitrophenolic species, identify how changes in the functional group identity and positioning has a strong influence on interactions with water. Further, we explore how particles containing mixtures of these chromophores with ammonium sulfate vary from the pure state, focusing on phase transitions and changes in the amount of condensed phase water. We extend our measurements to chamber generated BrC SOA to characterize the hygrosopic growth and phase behavior of chemically complex samples. Finally, we describe preliminary work on the photolysis chemistry of individual chromophores held in levitated particles across a range of compositions using single particle levitation coupled with mass spectrometry. Overall, these measurements facilitate a compositionally-resolved investigation into the physical properties and chemistry of BrC aerosol that will improve our understanding of this important class of atmospheric aerosol.

7AC.2

Unraveling the Link between Real-Time Light-Absorption Properties and Offline Molecular Composition of Brown Carbon Aerosol.

VAIOS MOSCHOS, Cade Christensen, Marc Fiddler, Barbara Turpin, Solomon Bililign, Jason Surratt, *NCAT & UNC-Chapel Hill*

The radiative forcing of aerosols remains uncertain owing to their diverse sources, variable physicochemical properties, and inhomogeneous spatial distribution. Biomass burning (BB) significantly contributes to aerosol emissions, including the chemically complex light-absorbing organic (brown) carbon (BrC).

We conducted a series of smog chamber combustion experiments using biomass fuels from sub-Saharan Africa, a global hotspot source region of carbonaceous aerosols. To simulate atmospheric conditions, we examined the effects of relative humidity and photo-aging on primary emissions. We analyzed filter samples with ultra-performance liquid chromatography coupled in-line to a diode array detector and a high-resolution quadrupole time-of-flight mass spectrometer, with the latter equipped with an electrospray ionization source operated in both positive and negative ion modes.

We identified 182 individual BrC species (including isomers) with diverse polarities, grouped into distinct chemical classes: guaiacol and syringol derivatives, nitro-aromatic compounds, coumarins, stilbenes, and flavonoids. Employing an extensive set of authentic standards with distinct chromatographic responses, absorbance spectra, and fragmentation patterns, we quantified the chromophoric species and attempted mass closure. Notably, the standards represented two-thirds of the BrC mass identified using this analytical platform. We applied multivariate data analysis to interpret the complex molecular composition matrix.

We linked the molecular composition to real-time aerosol light-absorption properties (e.g., mass absorption cross-section, absorption Ångström exponent) based on calibrated aethalometer measurements. Furthermore, we assessed the atmospheric relevance of the chamber-generated BrC by analyzing night-/day-time aerosol filter samples from two locations in Botswana, Africa, at the onset of the 2022 fire/heating season (June-July).

Our study offers molecular-level insights into the emission/transformation of BB-derived BrC aerosol constituents associated with one of the world's major yet neglected source regions, towards elucidating their environmental and climate-relevant effects.

VM acknowledges support from the Swiss-NSF (Postdoc.Mobility P500PN_210745). Field collection and chemical analysis are funded by the NSF (OISE-1559308, AGS-2100708).

7AC.3

Wildfire Emissions - Source Apportionment and Ageing Effects Analyses via Single-Particle Profiling of Polycyclic Aromatic Hydrocarbons. JOHANNES PASSIG, Ellen-Iva Rosewig, Julian Schade, Mika Ihalainen, Kerneels Jaars, Kajar Köster, Stefan Siebert, Olli Sippula, Markus Somero, Pasi Yli-Pirilä, Pieter G. van Zyl, Annele Virtanen, Ville Vakkari, Andreas Walte, Ralf Zimmermann, *Helmholtz Zentrum München and University of Rostock*

Open fires emit large amounts of carbon dioxide, reactive trace gases and particulate matter, thus affecting air quality, human health, climate and the earth system (e.g. van der Werf et al., 2017, Yue et al., 2018). Atmospheric ageing and the distribution of these aerosols are complex and highly variable, emphasizing the need for novel source apportionment strategies. In addition, chemical changes of climate- and health-relevant particle components are of particular interest.

A unique method to chemically characterize particles in complex aerosols is single-particle mass spectrometry (SPMS). The method yields the size and a chemical fingerprint from individual particles in real time, providing intriguing insights into the mixing state and distribution of relevant substances in aerosols. Recently, we introduced a new ionization technique to extend the chemical coverage of SPMS to polycyclic aromatic hydrocarbons (PAHs) (Schade et al. 2019).

Here we present results from the first single-particle study on aerosols from smouldering fires of boreal forest floor, savannah wood and savannah grass material as proxies for wildfires in the respective regions. We found that these fires produce distinct PAH patterns that differ from most anthropogenic sources – providing a new route for source apportionment based on PAHs (Passig et al. 2022). The emissions were aged in the atmospheric chamber of the ILMARI facility in Kuopio, Finland. With the real-time capabilities of our technique, we could show that PAHs are rapidly degraded, at least at the particle surface. Furthermore, some PAH signatures were depleted after less than one hour, while other ones emerged with beginning of the photooxidation ageing. The PAH distributions in the particle ensemble suggest an initially high mobility of PAHs between the particle phase and the gas phase. We also discuss correlations between PAHs, oxidation products and the particle’s inorganic particle composition on a single-particle basis.

[1] Van der Werf, G. et al. (2017), Earth Syst. Sci. Data, 9, 697–720.
[2] Yue, X. et al. (2018), Nat. Commun., 9, 5413.
[3] Schade, J. et al. (2019) Anal. Chem. 91, 15, 10282–10288.
[4] Passig et al. (2022) Atmos. Chem. Phys., 22, 1495–1514.

7AC.4

Laboratory Constraints on Photochemical Processing of Biomass Burning-Derived Secondary Organic Aerosol. MARIA ZAWADOWICZ, Yuzhi Chen, John Shilling, Gregory W. Vandergrift, Tania Gautam, Swarup China, Arthur J. Sedlacek, *Brookhaven National Laboratory*

Biomass burning events, such as wildfires, are a substantial, and potentially increasing, source of primary and secondary aerosol and reactive gas emissions into the free troposphere. As the fire plumes age, biomass burning-derived aerosols and gases undergo photochemical processing, which can result in changes to aerosol organic mass and chemical transformations that impact their optical and hygroscopic properties. Capturing those processes in global climate models is important for constraining organic aerosol mass and correctly predicting both direct and indirect effects of aerosols on climate. Recently Sedlacek et al. have described biomass burning aerosol lifecycle using data from multiple field measurements, showing a fast (first few hours) initial organic coating accumulation through secondary organic aerosol (SOA) formation, followed by a slow (1-10 days) loss of 75% of the organic coating. This presentation reports results of laboratory experiments aimed at constraining the efficiency of SOA production from two biomass burning-derived volatile organic compounds, guaiacol and furfural, and its subsequent loss via direct photolysis. Guaiacol and furfural SOA was produced via OH oxidation in a 10.6 m^3 environmental chamber under low- and high- NOx conditions, and subsequently aged with UV exposure for ~12 hours. Additionally, changes to the SOA composition following aging were characterized using high-resolution mass spectrometry. Guaiacol- and furfural-derived SOA was found to be non-photolabile compared to biogenically-derived SOA produced from oxidation of isoprene and α-pinene, suggesting longer atmospheric lifetimes of biomass burning-derived SOA, consistent with field campaign data.

7AC.5

Effects of Relative Humidity on Secondary Organic Aerosol and Brown Carbon Formation from Nighttime Oxidation of Furan and Pyrrole. KUNPENG CHEN, Caitlin Hamilton, Bradley Ries, Michael Lum, Raphael Mayorga, Linhui Tian, Roya Bahreini, Haofei Zhang, Ying-Hsuan Lin, *University of California, Riverside*

Wildfires are an important source of volatile organic compound precursors for secondary organic aerosol (SOA) formation, and the resulting light-absorbing SOA (also known as secondary brown carbon, BrC) has the potential to perturb the Earth's energy budget and contribute to climate change. The chemical composition and optical properties of SOA are significantly influenced by environmental factors such as pre-existing particles and relative humidity (RH). Specifically, an increase in RH may change gas-phase reactions or introduce aerosol liquid water (ALW) on the pre-existing particles, but the effects of RH on SOA composition and secondary BrC's light absorption are not fully constrained in current climate models. An in-depth understanding of the correlation between environmental factors and secondary BrC's light absorption is hence required for more accurate parameterization. Here, we conducted chamber experiments with a suite of online and offline instruments to examine the influence of RH (<20% and ~50%) on SOA and secondary BrC formation from nighttime oxidation of furan and pyrrole, two typical heterocyclic VOCs emitted in wildfires. Our results showed that an increased RH can facilitate particulate growth in furan SOA while inducing new particle formation with impeded particulate growth in pyrrole SOA. Yet, the presence of RH decreased the mass absorption coefficients (MAC) of both BrC systems. A detailed compositional analysis revealed that RH can increase the fraction of oxygenated products in both SOA systems, in which the non-absorbing, high-molecular-weight products may account for the decreased MAC. Furthermore, hydrolysis driven by ALW might have depleted molecular chromophores and contributed to the change in MAC profiles. Overall, this study demonstrated that RH may be important in modulating SOA composition and the optical properties of secondary BrC in the wildfire plumes.

7AC.6

Formation and Properties of Secondary Organic Aerosol from Gas-Phase and Aqueous-Phase Oxidation of Guaiacyl Acetone. CLAIRE MOFFETT, Gregory W. Vandergrift, Zezhen Cheng, Jie Zhang, Swarup China, ManishKumar Shrivastava, Alla Zelenyuk, *Pacific Northwest National Laboratory*

Biomass burning is a significant source of particulate matter in the atmosphere contributing to approximately 10−50% of the total organic aerosol mass. Methoxyphenols are a dominant product of biomass burning that are emitted in high concentration making them an excellent tracer of biomass burning. Guaiacyl acetone (GA, 4-hydroxy-3-methoxyphenolacetone) is a semivolatile methoxyphenol formed from lignin depolymerization which can undergo rapid aqueous oxidation to form secondary organic aerosol (SOA). This aqueous phase processing is thought to be important for aerosol chemistry especially in cloud and fog droplets and in aerosol liquid water. An increased understanding of its role in biomass burning SOA formation and the effects of aerosol liquid water on the chemistry would improve model predictions of aqueous SOA chemistry.

We will present the results of a recent study focused on the formation and properties of SOA particles formed by the photosensitized oxidation of GA by an organic triplet excited state (3C*) in aerosol liquid water. The properties of these SOA particles are compared to SOA particles formed by the gas-phase oxidation of GA by the hydroxyl radical. The experiments were conducted at low (<5%) and elevated (~50%) relative humidity (RH) with and without ammonium bisulfate seeds. We find, for example, that guaiacyl acetone SOA formed by gas-phase oxidation at low RH are highly viscous and nearly non-volatile, losing only 8% of their volume after >24 hours of evaporation at 75% RH, while not shrinking at all during the same evaporation time at low RH. We show that larger, size-selected SOA particles are aspherical agglomerates of spherical nanoparticles that do not coalesce even after 24 hours. However, at increased RH these particles coalesce to form spherical particles, making it possible to estimate particle viscosity as a function of relative humidity.

7BA.1

Modified Cascade Impactor for Liquid Collection and Increased Sampling Time. JANA KESAVAN, Daniel Mcgrady, Jerold Bottiger, *U.S. Army DEVCOM Chemical Biological Center*

It is essential to have the capability to size selectively sample bioaerosols for long duration and analyze the collected samples using various methods. However, currently available samplers do not have this capability. Therefore, we modified a cascade impactor for sample collection on wet filters and for long duration sampling. Collection petri dishes with agar were replaced with petri dishes with porous polyethylene plastic disks and collection liquid. A filter was placed on top of the disk for particle collection by impaction. This setup allowed organism collection for 1-4 hours which depended on the environmental conditions. The sample time can be increased by adding collection liquid to the petri dishes as the liquid evaporates. This method allowed for organisms to be collected on wet filters, recovered into liquid and analyzed by PCR, culturing, immunoassay, etc. The polyethylene plastic disks can be autoclaved in between tests for decontamination. Tests with pipetted organisms and 2.5 hours of sampling indicated that when 1.1E5 cfu/stage was observed in the modified cascade impactor, the agar filled plates were dry and no organisms were observed after incubation. Our studies indicated that the modified cascade impactor allowed for long term, size selective sampling that allowed for the use of various sample analysis techniques.

7BA.2

Detection and Isolation of Infectious SARS-CoV-2 Omicron Variants Collected from Residential Settings. WILLIAM VASS, Sripriya Nannu Shankar, John Lednicky, Carlos Manzanas, Yuetong Zhang, Jessica Boyette, Jiayi Chen, Yuqiao Chen, Amin Shirkhani, Mo Washeem, Yang Yang, Z. Hugh Fan, Arantzazu Eiguren-Fernandez, Chang-Yu Wu, *University of Florida*

Introduction:
Airborne transmission of infectious SARS-CoV-2 is increasingly accepted as the primary manner by which the virus is spread between people. Risk of inhalation exposure to the virus is high in enclosed and poorly ventilated spaces. We present a study focused on air sampling within residential environments occupied by individuals with COVID-19.

Method:
Air samplers (BioSpot-VIVAS, VIVAS, and BC-251) were positioned in primary- and secondary-occupancy regions in the homes of seven volunteers. Additionally, surface swab samples were collected from high-touch surfaces. Air and surface samples were processed by RT-qPCR. Isolation of SARS-CoV-2 in Vero E6 cells and LLC-MK2 cells was attempted for samples with detectable virus. Viable virus was quantified by plaque assay, and sequencing of SARS-CoV-2 was conducted for select samples according to the sampling day.

Results:
SARS-CoV-2 was detected in 24 of 128 samples (18.8%) by RT-qPCR and isolated from 14 (11.0%) in cell cultures. It was detected in 81.0% (17/21) and cultured from 61.9% (13/21) of samples that were collected using water condensation air samplers. No statistically significant differences existed in the likelihood of virus detection by RT-qPCR or amount of infectious virus in the air between areas of primary and secondary occupancy within residences. The SARS-CoV-2 isolated from all residences was determined by Sanger sequencing to belong to the omicron-lineage variant of concern.

Conclusions:
Our work provides information about the presence of SARS-CoV-2 in the air within homes of individuals with COVID-19. Information herein builds knowledge about the existence of infectious SARS-CoV-2 in the air. The demonstrated presence of virus beyond primary-occupancy spaces provides health agencies with information to apply to recommendations regarding airborne exposure risks in homes of sick individuals, such as enhancing air exchange rates, operating air purifiers, and using personal respiratory protection devices.

7BA.3

Estimating Indoor Airborne Concentrations of SARS-CoV-2.

ZOE HOSKIN, Jeffrey Siegel, Sarah R. Haines, *University of Toronto*

Environmental surveillance of SARS-CoV-2 virus is a critical tool in COVID-19 pandemic recovery efforts. A surveillance method is needed that 1) has less particle size bias than sampling settled dust, 2) is spatially specific to a room within a building, and 3) provides an estimate of airborne concentrations in a room. Therefore, portable air cleaner filters may be leveraged as a tool to assess concentrations of SARS-CoV-2 RNA in indoor spaces using portable air filters and quantitative filter forensics (QFF) techniques. Approximate one-week trials were conducted in residences of covid-symptomatic individuals, classrooms, and community locations in Toronto. Dust from the filters was vacuumed, and then RNA extraction, reverse-transcription-quantitative-polymerase-chain-reaction (RT-qPCR), and digital PCR (dPCR) were performed on the dust samples to quantify SARS-CoV-2 RNA. Metadata from the portable air cleaners was used to determine airborne concentrations of SARS-CoV-2 RNA in each room. The highest airborne concentrations of SARS-CoV-2 RNA in residences were found in the rooms of people who were isolating due to COVID-19 symptoms (ranging from 0.7 to 63.0 RNA copies/m3 air). Disease state (days since symptom onset) may play a role in determining airborne SARS-CoV-2 concentrations in isolation rooms. Other rooms in residences had present, but comparatively low, viral RNA concentrations. Classrooms had low viral concentrations in the summer months when fewer classes were occurring, and higher concentrations during the fall, winter, and spring. Sampling from two filters on different sides of one classroom at the same time revealed very different estimated indoor concentrations of SARS-CoV-2, which may suggest poor air mixing, particularly with respect to localized sources of the virus. In the future, quantitative filter forensics may be applied to building-level surveillance and outbreak-prevention for other airborne viruses.

7BA.4

Quantifying Aerosol Effective Air Change Rate in the USNS Mercy Hospital Ship, and Optimizing Placement of Infectious Patients and Portable HEPA Filter Mitigations.

SEAN KINAHAN, Donald Huston, David Silcott, Gabriel A. Lucero, Rick Arestad, Ryan Silcott, Braden Silcott, Blake Silcott, Peter Silcott, Daniel N. Ackerman, Joshua L. Santarpia, *National Strategic Research Institute*

The United States Navy has two hospital ships, USNS Mercy and USNS Comfort, which responded to the COVID-19 pandemic by deploying to Los Angeles and New York City. These 1000+ bed ships have multiple intermediate and limited care wards that used to house potentially infectious patients. These wards have older HVAC systems that were not designed to modern ASHRAE recommendations of 6 Air Changes Per Hour (ACH), and were not designed with treatment of communicable infectious disease patients as a primary mission.

In the wake of these deployments, and the pandemic response, we characterized the existing functionality of three open wards upon the USNS Mercy across two decks, capturing particle escape and penetration to nearby hallways and wards, and the wards effective air change rate for test aerosols at multiple locations. Further, testing included five release locations, and four different portable HEPA filter configurations to determine which placement, and how many, was optimal.

Particle transport and removal times were captured using IBAC real-time fluorescent particle spectrometers, with a fluorescent threshold set to allow for distinguishing 1 µm fluorescent PSL particles from naturally occurring background populations, including most biological aerosols.

Generally, the lower ward 6 had an order of magnitude less penetration of test aerosols into the HVAC system and distributing to nearby hallways and spaces. Increasing the number of 1000 CFM HEPA filters within the ward improved the effective air change rate, with between 3 and 5 HEPA filters necessary to achieve the 6 ACH recommended today, depending on which ward. Effective air change rates and integrated particle counts were utilized to explore exposure rate differences. Using a Wells-Riley model, increasing from 0 and 5 HEPA filters could increase the time required to reach a given probability of infection by 2-3 times, depending on ward and placement.

7BA.5

Airborne Microbiota and their Disease, Ecological and Social Implications for 31 Major Chinese Mainland Cities. LU ZHANG, Maosheng Yao, *Peking University*

Microbial aerosol exposure represents a major health threat toward humans. Here, particulate matter (PM) samples from a total of 465 automobile air conditioning (AC) filters were collected from 31 major Chinese mainland cities to analyze the airborne distribution of bacterial, fungal and RNA viral communities. Our results showed that airborne microbiota including pathogenic microorganisms containing genera varied greatly among 31 major cities, thus representing different health risks. The relative abundances of some bacterial genera such as Brevibacterium were extremely high in PM from some cities such as Changsha. Significant north-south differences in fungi community structures were observed with higher abundances of *Trichoderma* and *Phoma* in northern China and higher abundance of *Cladosporium* in the south. Varying RNA virus structures were detected in 16 cities' samples with family *Virgaviridae* abundant from over half of the 31 cities. Using redundancy (RDA), variance partition (VPA) and aggregated Boosted tree (ABT) analysis, environmental factors, especially relative humidity, were found to have played a leading role, followed by air pollutants and social factors. However, as for bacteria, social factors, especially the secondary industry, had the greatest impact on the bacteria community structures, followed by environmental factors and air pollutants. In contrast, only temperature was shown fitting with the relative abundance profile of top 20 bacteria and fungi genera based on random forest regression (R^2= 0.774). Environmental, social-economic and ecological factors were found to form a unique microbiota fingerprint for a particular city. The structure was shown to be further influenced by interactions among the microbial agents as implied by their positive or negative associations across species. Information developed here is of great importance to develop geophysical microbial aerosol fingerprints, while providing national database for airborne microbes to guard human health.

7BA.6

Towards Preventing the next Pandemic: Hybrid Microfluidic Real-time Detection of Airborne Pathogens. Nitin Jayakumar, Michael Caffrey, IGOR PAPROTNY, *University of Illinois at Chicago*

Airborne pathogens are a reoccurring global health hazard. In December of 2019, a novel coronavirus (CoV) outbreak in the Wuhan region of China became evident, subsequently called SARS-CoV-2 virus, the causative agent of COVID-19. The number of COVID-19 cases quickly surpassed that of the 2003-2004 SARS-CoV outbreak and is the most-deadly pandemic since the 1918 influenza epidemic. In this work, we present the development of an air-microfluidic real-time air-borne pathogen detector, a concept we call "Bioaerium". This talk will address the unique challenges of combining DNA-based pathogen detection with air-microfluidic deposition in a hybrid microfluidic setup, yielding a chip-based detection scheme that has a form-factor of a smoke detector. We will present the Bioaerium technology, and show detection results using a SARS-CoV-2 model, aerozolized deactivated SARS-CoV-2 virus, as well as detection results from a COVID-19 hospital ward. We will address the utility of detecting other pathogens beyond SARS-CoV-2, and touch on our ability to screen for known and unknown mutations using AI. The research is a collaboration between UIC School of Engineering and UIC School of Medicine.

7CA.1

Optical Properties of Biomass Burning Particles in the G-WISE Campaign. ZACHARY MCQUEEN, Ryan Poland, Chase Glenn, Omar El Hajj, Kruthika Kumar, Anita Anosike, Robert Penland, Rawad Saleh, Joseph O'Brien, Geoffrey Smith, *University of Georgia*

Studies of the radiative effects of biomass burning aerosols have largely been dedicated to those generated by wildfires. Prescribed fires, however, play a significant role in forest management and ecological development, and there is a lack of fundamental science supporting regulations governing prescribed burns (1). The Georgia Wildland-fire Simulation Experiment (G-WISE) was a month-long, collaborative campaign in Athens, Georgia, designed to characterize the difference between wild (dry conditions) and prescribed (moist conditions) fires from fuels from three representative eco-regions in Georgia: Piedmont, Coastal Plain and Blue Ridge. Optical properties of the particle emissions were measured using a four-wavelength (406 nm – 783 nm) photoacoustic spectrometer for absorption and two cavity ringdown spectrometers (445nm and 663 nm) for extinction (2). For both wild and prescribed conditions, the single scattering albedo (SSA) at 663 nm was found to correlate strongly with the absorption Ångström exponent (AAE) over a wide range of SSA (0.70-0.99) and AAE (1-4). Combustion of the Blue Ridge fuel, which contains an organic rich sublayer (duff), produced aerosols with a large fraction of absorption, at 406 nm, attributable to brown carbon (70-78%), with high AAE (3.5-4.0) and high SSA (0.97-0.99). The AAE and SSAs were also found to be highly correlated with the elemental carbon to total carbon ratio (R2=0.95) measured with an EC: OC analyzer. The strong correlations observed between these optical properties could allow radiative transfer models to account for variability in biomass burning conditions and fuel types with a simple parameterization.

[1] Hiers, J. K. et al. Prescribed fire science: the case for a refined research agenda. Fire Ecol 16, 11 (2020).
[2] Fischer, D. A. & Smith, G. D. A portable, four-wavelength, single-cell photoacoustic spectrometer for ambient aerosol absorption. Aerosol Sci Tech 52, 393–406 (2018).

7CA.2

Initial Findings of the African Combustion Aerosol Collaborative Intercomparison Analysis (ACACIA) Pilot Project. MEGAN MOUTON, Vaios Moschos, Marc Fiddler, Kyle Gorkowski, Abu Sayeed Md Shawon, Nevil Franco, Katherine Benedict, Barbara Turpin, Jason Surratt, Manvendra Dubey, Solomon Bililign, *North Carolina A&T State University*

Biomass burning (BB) plays a vital role in the formation of climate-relevant atmospheric aerosols, whose optical properties are influenced by factors such as combustion type, chemical composition, and aging processes. In this study, we analyzed the optical properties of carbonaceous aerosols emitted from common sub-Saharan African biomass fuels, including acacia, eucalyptus, mopane, wanza, savanna grass, and cow dung.

The emissions were generated by burning these fuels under controlled conditions in a tube furnace. At North Carolina A&T State University (NCAT), combustion emissions entered a 9-m^3 indoor smog chamber, while at Los Alamos National Lab (LANL), they were introduced into a 0.034-m^3 mixing tube.

At NCAT, we measured light-extinction (scattering + absorption), scattering, and attenuation coefficients using a cavity ring-down spectrometer (CRDS), an integrating-sphere nephelometer, and a dual-spot aethalometer (AE33), respectively. We calculated mass-normalized coefficients, Ångström exponents, and optical-based emission factors. The intensive BB aerosol optical properties show considerable variability, influenced by factors such as fuel type, chamber relative humidity, and simulated aging in the presence of atmospheric oxidants and UV light.

At LANL, we employed the AE33, a cavity attenuated phase shift single-scattering albedo particle monitor (CAPS PMssa), and a photoacoustic soot spectrometer (PASS-3) to determine the BB aerosol optical properties and single scattering albedo (SSA, scattering/extinction ratio) at blue, green, and red wavelengths. We examined the dependence of the AE33 multiple-scattering correction factor on SSA and the impact of combustion type and aging degree on both variables. Wavelength dependence in SSA was observed in smoldering-dominated (less efficient) burns emitting high amounts of organic carbon.

By presenting and comparing the results from both laboratory analyses, we aim to address the knowledge gap concerning BB aerosol emissions in Africa, a region that has been underrepresented in prior research.

7CA.3

Chemical Composition and Optical Properties of Laboratory-generated Biomass Burning Organic Aerosols. FELIPE RIVERA-ADORNO, Jay Tomlin, Theo Paik, August Li, Kyla Siemens, Zezhen Cheng, Nurun Nahar Lata, Ryan Moffet, Matthew Fraund, Swarup China, Rajan K. Chakrabarty, Alexander Laskin, *Purdue University*

Biomass burning organic aerosols (BBOA) impact Earth’s climate directly by scattering and absorbing sun light, and indirectly by modifying processes controlling cloud formation and lifecycles. This alteration to our planet’s climate is highly influenced by variability in the chemical composition, morphology, and mixing states of individual BBOA particles. In this work, four types of biomass fuels (i.e., grass, sage, peat, and pine) were burned in a laboratory combustion chamber to mimic BBOA representative of North American wildfires. BBOA samples were then collected using a cascade impactor for further single-particle chemical imaging. Samples of individual particles were probed using a computer-controlled scanning electron microscope coupled with energy dispersive X-ray microanalysis (CCSEM/EDX), which provided information on the particle-types determined based on the elemental composition and morphology. Complementary synchrotron-based soft X-ray microscopy (STXM/NEXAFS) was utilized to investigate and quantify extents of external and internal mixing. The later technique also provided advanced speciation of carbon bonding within individual particles, allowing to distinguish between organic and elemental carbon (soot), and inorganic components. Parameterized mixing state metrics were then correlated with online optical measurements recorded during each of the individual burning experiments. Results have shown significant differences in the elemental composition, with peat and grass being dominated by high content of organic material, while sage and pine are rich in inorganics. Additionally, the content of elemental carbon and inorganics per sample was found to increase bulk and individual particle chemical diversity, with further impact on the optical properties (i.e., mass absorption coefficient and absorption Angstrom exponent).

7CA.4

Advanced Characterization of Aerosol Optical Properties, Sources and BrC Ageing With the New 9λ Aethalometer Model AE36s. ASTA GREGORIČ, Bálint Alföldy, Gašper Lavrič, Matic Ivančič, Irena Ježek Brecelj, Amalia Muñoz, Mila Ródenas, Ruben Soler, Esther Borrás, Teresa Vera, Eduardo Yubero, Rok Podlipec, Martin Rigler, *Aerosol d.o.o.*

Aerosol light absorption measurements are important for assessing the effects of aerosols and their mixing state on the radiative balance of the atmosphere. The absorption spectral dependence can be expressed by the absorption Ångström exponent (AAE), which assumes a power law relationship and is used to identify the types and sources of light absorbing aerosols, such as black carbon (BC) and brown carbon (BrC).

AAE is usually calculated by fitting a linear function to the logarithm of the absorption coefficients at two or more wavelengths. However, the absorption spectra show different features across the UV and visible wavelength range, due to the specific absorption properties of different BrC compounds. To better characterize BrC absorption, two additional wavelengths were added in the new 9λ Aethalometer model AE36s (Aerosol Magee Scientific): (a) 400 nm, which fills the gap between 370 nm and 470 nm, and (b) 340 nm, which extends the measurement range to the UV spectrum.

Long-term measurements with the AE36s were performed at an urban background site in Ljubljana (Slovenia) in winter – spring period in 2021/22 and 2023, and compared with results obtained in the EUPHORE simulation chamber for different fuel types, burning conditions and aging states. AAE was analyzed for the long ($AAE_{590-950}$; 590-660-880-950 nm) and short spectral range ($AAE_{400-520}$; 400-470-520 nm) separately, which allowed us to distinguish between different absorption patterns.

Results from the Ljubljana campaign presented as a dual AAE plot revealed several specific events, which could be differentiated from the urban aerosol absorption pattern: e.g. industrial fire emission, open fire burning and fresh BrC emission.

7CA.5

Atmospheric Lifetime of Primary Brown Carbon Can Be Increased by Ultraviolet Irradiation. Habeeb Al-Mashala, Katrina Betz, Colton Calvert, Jace Barton, Elevia Bruce, ELIJAH SCHNITZLER, *Oklahoma State University*

Biomass burning organic aerosol (BBOA) impacts climate directly by scattering and absorbing solar and terrestrial radiation. The fraction of BBOA that absorbs visible sunlight is called brown carbon (BrC), and its absorptivity can change during its atmospheric residence time, in part due to multiphase oxidation. For example, multiphase ozonolysis leads to whitening of primary BrC constituents. Irradiation, in addition to multiphase processing, can also change the properties of BrC. Here, we investigate the interplay between irradiation and multiphase processing by measuring the reactive uptake of ozone to thin films of BBOA before and after their exposure to UV radiation in a photoreactor, with peak emission at 310 nm. The thin films were prepared from the lower volatility fraction of BBOA collected from the smoldering sapwood of eastern red cedar, a species that is associated with wild- and prescribed fires in the southern Great Plains of the United States. Irradiation increased the mass absorption coefficient of the BrC at near-UV and visible wavelengths. It also significantly decreased the reactive uptake of ozone, a result attributed to increased viscosity of the BBOA material. These changes in absorptivity and viscosity are consistent with results of mass spectrometry and volatility tandem differential mobility analysis, which show that high-molecular-weight species constitute a greater fraction of the total mass after irradiation. The mass loss during irradiation is negligible, so this change in fraction likely occurs from the formation of oligomers from monomers and dimers of phenolic species, which initially originate from the thermal degradation of lignin. Our results have significant implications on the warming effect contributed by BrC, since UV irradiation both darkens BBOA material and makes it more resistant to whitening upon multiphase processing by oxidants, including ozone.

7CA.6

Modelling the Response of Tar Brown Carbon (Tarballs) to Pulsed Laser-induced Incandesce (P-LII). FENGSHAN LIU, Joel Corbin, Timothy Sipkens, Gregory Smallwood, *National Research Council Canada*

Tar brown carbon (TB) is an important class of light-absorbing carbon produced in biomass burning and heavy fuel oil combustion. TB particles display an amorphous-carbon molecular structure and have diameters from about 50 to 500 nm. The reported imaginary part of refractive index for TBs from all sources varies by two orders of magnitude from 0.002 to about 0.27 in the visible spectrum, which are significantly lower than mature soot at visible and near infrared wavelengths. Correspondingly, it has been believed that TB cannot be detected using pulsed laser-induced incandescence (P-LII). However, it has been demonstrated that certain TB particles can indeed incandesce in a single particle soot photometer (SP2), a continuous-wave LII (CW-LII) instrument. That observation was explained by laser-induced carbonization of TB during laser heating in SP2.

In this study, an LII model was built to account for laser-induced carbonization of TB particles during P-LII. The particle absorption cross section was calculated as a weighted average between TB and mature soot. Heat conduction was modelled using the Fuchs method valid over the entire Knudsen regime from free-molecular to continuum. The carbonization of TB was modelled as an annealing process.

The results show that the peak TB particle temperature during P-LII increases nearly linearly with the laser fluence. Using a 1064 nm excitation laser, a fluence of 12.6 mJ/mm2 is required to heat the peak TB particle (200 nm in diameter) to a temperature of 2500 K. This fluence is about a factor of 6 higher than the typical P-LII fluence used for soot measurements. This study explains why TB particles have not been detected using P-LII in previous studies and confirms that TB particles can potentially be detected using P-LII at sufficiently high laser fluences, opening the door for future diagnostics for these kinds of particles.

7CC.1

Quantifying the Surface Tension of Aerosol through Single Droplet Measurements and Modeling Surfactant Partitioning.

ALISON BAIN, Kunal Gosh, Nønne L. Prisle, Bryan R. Bzdek, *University of Bristol*

The surface tension of aerosol is a necessary parameter in understanding the morphology of spray dried particles, droplet spreading on surfaces, new particle formation and cloud droplet activation. In atmospheric science, the Köhler equation is used to predict the number of cloud droplets that will activate at a given level of supersaturation. A common assumption to these predictions is that the surface tension of a droplet is equal to water. However, using this assumption, field studies can greatly underpredict the number of cloud condensation nuclei (CCN). In some cases, reducing the surface tension leads to better predictions of CCN concentrations.

Field studies have also found large concentrations of surfactants in aerosol samples. Surfactants, organic molecules that preferentially adsorb to interfaces including aerosol droplet surfaces, reduce the surface tension. A reduction in aerosol surface tension due to surfactant adsorption has been suggested to explain the discrepancies between CCN observations and predictions. However, surface tension is typically measured with macroscopic samples. In high surface-area-to-volume ratio droplets, surfactant partitioning to the surface can leave the bulk concentration depleted, thus requiring a larger total surfactant concentration to reduce the surface tension. This size-dependent surface tension can be described with a partitioning model.

Here, we investigate the partitioning behaviour for a variety of surfactants having surface activities similar to the range of surfactants found in atmospheric samples. Comparing surface tensions of droplets to macroscopic solutions shows depletion occurs in most systems. Additionally, we compare a thermodynamic partitioning model and a simple kinetic partitioning scheme to predict the surface tension and critical activation point of aerosol droplets. These results highlight the importance of considering bulk-to-surface partitioning in surfactant containing aerosol droplets and that it is crucial to choose a partitioning scheme that accurately describes droplet surface tension in order to make better predictions of cloud formation.

7CC.2

Comprehensive Analysis of Particle Growth Rates at an Agricultural Site.

ELEANOR BROWNE, Jennifer Berry, Bri Dobson, Daniel Katz, *University of Colorado Boulder*

Elucidating the processes by which particles grow to sizes at which they can act as cloud condensation nuclei (CCN) is critical for constraining the global energy budget. However, the understanding of the key processes governing particle growth remains weak particularly the relative roles of condensational growth versus condensed-phase chemistry. Growth rates (GR) have typically been calculated for nucleation mode particles; however, as particles typically need to grow to 50-100 nm in diameter to act as CCN, it is necessary to understand how GR varies with particle diameter. Here, we analyze approximately six years of particle size distribution data in combination with meteorological data to investigate the processes controlling particle growth at the Department of Energy Atmospheric Radiation Measurement Southern Great Plains site. We use an automated algorithm to find regional aerosol growth events (>2 h of monotonic growth) for starting particle sizes ranging from ~20 nm to ~450 nm and calculate the growth rates. Across all starting diameters, growth rates are observed to increase with temperature. At lower temperatures, a size dependent growth rate is observed suggesting that condensed-phase chemistry may be important for particle growth. Using the change in aerosol chemical composition during growth events, we infer that growth driven by a combination of organic and inorganic compounds is typically faster than growth by either inorganic or organic compounds only. Back trajectory analysis provides insight into potential sources of the gas-phase precursors. We use these results to investigate how particle growth influences the concentration of cloud condensation nuclei at the site.

7CC.3

Cloud Condensation Nuclei Activity of Internally Mixed Particles at a Remote Marine Free Troposphere Site in the North Atlantic Ocean. ZEZHEN CHENG, Megan Morgenstern, Silvia Henning, Bo Zhang, Greg Roberts, Matthew Fraund, Matthew A. Marcus, Nurun Nahar Lata, Paulo Fialho, Lynn Mazzoleni, Birgit Wehner, Claudio Mazzoleni, Swarup China, *Pacific Northwest National Laboratory*

In this study, we report results from research conducted at the Observatory of Mount Pico (OMP), 2225 m above mean sea level on Pico Island in the Azores archipelago in June and July of 2017. We investigated the chemical composition, mixing state, and cloud condensation nuclei (CCN) activities of long-range transported free tropospheric (FT) particles. FLEXible PARTicle Lagrangian particle dispersion model (FLEXPART) simulations reveal that most air masses that arrived at the OMP during the sampling period originated in North America and were highly aged (average CO age >10 days). We probed size-resolved chemical composition, mixing state, and hygroscopicity parameter (κ) of individual particles using computer-controlled scanning electron microscopy with an energy-dispersive X-ray spectrometer (CCSEM-EDX). Particles were mostly carbonaceous (~29.7-68.9% by number), but there was a significant fraction of highly aged sea salt (~8.8 to 31.6 %) and sea salt with sulfate (~5.2 to 31.5 %) particles since air masses were transported above the North Atlantic Ocean. Based on the estimated elemental composition of individual particle mass, we calculated the mixing state index, χ. During our study, most FT particles were internally mixed (χ of samples are between 78% and 93%), owing to the long atmospheric aging time. We used data from a miniature Cloud Condensation Nucleus Counter (miniCCNC) to derive the hygroscopicity parameter, κCCNC. Combining κCCNC and FLEXPART, we found that air masses recirculated above the North Atlantic Ocean with lower mean altitude had higher κCCNC due to the higher contribution of sea salt particles. We also used CCSEM-EDX and phase state measurements to predict κ (κCCSEM-EDX) values. The κCCSEM-EDX values overlap with the lower range of κCCNC measured below 0.15% supersaturation. Therefore, CCSEM-EDX measurements can be useful in predicting the lower bound of κ, which can be used in climate models to predict CCN activities.

7CC.4

Aircraft Measurements Reveal Size and Mixing State of Individual Aerosol Particles Dictate Their Activation into Cloud Droplets. ALLA ZELENYUK, Georges Saliba, David Bell, Kaitlyn Suski, Jerome Fast, Gourihar Kulkarni, Fan Mei, Johannes Mülmenstädt, Mikhail Pekour, John Shilling, Jason Tomlinson, Adam Varble, Jian Wang, Joel A. Thornton, Dan Imre, *Pacific Northwest National Laboratory*

Shallow convective clouds are common in many regions of the world. Currently, aerosol-cloud interactions parameterizations for convective clouds are a major source of uncertainty in global climate model predictions of radiative forcing. Size and mixing state of ***individual*** aerosol particles are the most important properties that determine aerosol activation into cloud droplets and the impacts of aerosol on aerosol-cloud-climate interactions. A challenge to accurately describe aerosol activation is often due to a lack of measurements of individual particle size and composition, making it necessary to rely on simplistic and, most often, unrealistic aerosol mixing state assumptions, which are known to lead to significant errors in predicted concentrations of cloud condensation nuclei (CCN). We will present the aircraft-based single-particle measurements of the size and mixing state of individual below-cloud particles, interstitial aerosol particles, and cloud droplet residuals during two contrasting seasons. Measurements reveal enhanced contribution from larger and sulfate-rich particles in cloud droplet residuals and provide direct evidence for sulfate and isoprene-epoxydiol-derived secondary organic aerosol (IEPOX SOA) formation in cloud droplets. We observe a strong dependence of the size and mixing state of below-cloud aerosol on their cloud droplet activation fraction during the spring campaign, when the observed dynamic range in aerosol properties was large. Furthermore, we report clear seasonal differences in the aerosol activation fraction (0.38±0.21 for spring and 0.20±0.08 for summer) over the Atmospheric Radiation Measurements (ARM), Southern Great Plains (SGP) atmospheric observatory in Oklahoma, consistent with high biogenic surface isoprene flux that drive the formation and growth of less-hygroscopic organic components during summer but not during spring when the measured aerosol composition was more variable. A closure between measured cloud droplet number concentrations and predicted CCN (using κ-Köhler theory and measurement-constrained aerosol properties, including their mixing state) revealed that the effective supersaturations of shallow cumuli ranged between 0.06% and 0.24%. This study highlights the importance of measuring particle-by-particle variability in size, composition, and mixing state to accurately represent their activation into shallow cumuli cloud droplets, even at a background site like SGP.

7CC.5

Turbulence-Aerosol-Cloud Interactions: Implications for Drizzle Initiation in the Presence of Ordinary and Giant Cloud Condensation Nuclei.

ROBERT MCGRAW, Yangang Liu, Virendra Ghate, *Brookhaven National Laboratory*

Nucleation theory forms the foundation for understanding drizzle formation in warm clouds in the kinetic potential (KP) model. The model inputs cloud droplet number concentration, liquid water fraction, and a turbulent diffusion coefficient, from which emerge a critical droplet size, defined by the condition that the rate of droplet growth by condensation and collection is balanced by evaporation, a barrier maximum at the critical size, and a steady-state barrier crossing rate identified with the drizzle formation rate. For the present study, the Köhler activation of water-soluble aerosols is included in the kinetic potential to form an integrated description of the effects of ordinary cloud condensation nuclei (CCN), particles having dry radii < 0.5 micron, and giant CCN (GCCN) on drizzling and non-drizzling clouds. Water-soluble GCCN in the 0.5 to 3 micron radius range are found to significantly reduce the KP drizzle barrier. Near the high end of this range (circa 2 micron for marine clouds) the barrier vanishes and drizzle occurs spontaneously. The combined model yields predictions for drizzle formation and its seasonal dependence consistent with observations. The new, broader framework provides theoretical basis for understanding how turbulence-aerosol-cloud interactions impact drizzle initiation in natural clouds and effectiveness of cloud seeding.

7CC.6

Positive and Negative CCN Drizzle Relationships in Cumulus and Stratus Clouds.

JAMES HUDSON, Stephen Noble, *Desert Research Institute*

The second aerosol indirect effect (AIE, cloud lifetime) is due to drizzle suppression by greater cloud condensation nuclei (CCN) concentrations, N_{CCN}. However, several observations in RICO Caribbean cumuli and POST California stratus revealed opposite positive relationships between N_{CCN} and drizzle drop concentrations, N_d. The sign and magnitude of these relationships depended on the CCN supersaturation (S), cloud droplet liquid water content threshold that defined cloud parcels, and on drop sizes. In both projects, first AIE (cloud brightness) was distinctly exhibited by strong positive N_{CCN}-cloud droplet concentration, N_c, relationships. This was true for CCN active at many different S. However, the largest cloud droplets (diameter > ~ 35 µm) showed negative relationships with N_{CCN} that are consistent with negative N_{CCN}-N_d.

In RICO strong positive N_{CCN}-N_d relationships for CCN active at low S (< 0.1%, larger CCN) such as at 0.04%, $N_{0.04\%}$, seemed to act like giant nuclei, GN, which have been perceived to induce drizzle. Though GN exhibited positive relationship with N_d these relationships were less statistically significant than the positive $N_{0.04\%}$-N_d relationships. Although $N_{0.04\%}$ does include some GN, most $N_{0.04\%}$ are smaller and in greater concentrations than N_{GN}. Moreover, unlike N_{GN}, $N_{0.04\%}$ was not related to low altitude wind speeds that produced the GN. Conventional strong negative N_{CCN}-N_d were found when exclusively high S N_{CCN} were considered by subtracting lower S N_{CCN} such as $N_{0.80\%}$ from $N_{1.2\%}$. Thus, in RICO second AIE was reduced by positive $N_{0.04\%}$-N_d relationships even to the extent of some positive $N_{1.2\%}$-N_d relationships. These results indicate that second AIE is differently affected by N_{CCN} active at various S.

In the POST stratus clouds these N_{CCN}-N_d relationships also varied with S. In some cases these relationships were similar to those in RICO, but in other cases N_{CCN}-N_d relationships were opposite of those of RICO. Opposite N_{CCN}-N_d relationships were also found between clouds within clean and polluted air masses and between relatively lower and higher altitudes within these stratus clouds.

7DI.1

Air Pollution Exposure Disparities Related to Sustainable Aviation Fuel in California. MICHAEL KLEEMAN, Yiting Li, Colin Murphy, Jinwook Ro, *University of California, Davis*

Sustainable Aviation Fuel (SAF) made from renewable carbon is the most promising near-term option to reduce GHG emissions from the aviation sector. However, most facilities that produce SAF through lipid hydrotreatment also produce Renewable Diesel (RD) used by trucks in the goods movement sector. Limited feedstocks mean that increasing the production of SAF will reduce the production of RD. Both SAF and RD yield reduced emissions of criteria pollutants relative to their traditional fossil fuel analogs. SAF has lower sulfur content and reduced PM emissions compared to traditional Jet-A fuel. RD has lower PM and NOX emissions compared to traditional diesel fuel. The shift between SAF and RD affects pollutant emissions from on-road diesel trucks, off-road diesel equipment, and aircraft, which could possibly change the health co-benefits, and exposure disparity trends.

In this study, two energy scenarios were developed across California: (i) high SAF adoption featuring a 18.9% SAF blend rate and 30.4% RD blend rate, and (ii) low SAF adoption featuring a 6.8% SAF blend rate and a 45.8% RD blend rate. Future year 2030 air quality simulations were carried out for both emissions scenarios over 32 randomly-selected weeks between 2026-2035 (to account for effects of medium-term meteorological cycles such as ENSO). The UCD-CIT chemical transport model was used to track primary and secondary PM from aviation and diesel sources. Ambient concentration and population exposure to PM2.5, PM number concentration, sulfate, NOX were analyzed. Exposures to PM from on-road diesel, off-road diesel equipment, and aircraft, were then estimated for different socio-economic classes. The results from this study identify the trade-off between SAF and RD in California and compare the benefits of two future energy scenarios across socio-economic classes.

7DI.2

Environmental Justice Implications of Distributive Equity and Near-Roadway Air Quality from Zero-Emission Vehicle Adoption in California. QIAO YU, Brian Yueshuai He, Jiaqi Ma, Yifang Zhu, *University of California, Los Angeles*

Zero-emission vehicle (ZEV) adoption is a crucial strategy for climate mitigation in California, with the potential to significantly reduce greenhouse gas emissions and air pollution. However, the environmental justice implications of ZEV adoption remain ambiguous and understudied. In this research, we endeavor to quantify ZEV adoption in California from 2015 to 2020 at the census tract level, with a particular focus on disadvantaged communities (DACs) and the effects on air quality in the Greater Los Angeles area. To achieve this, we employ an integrated traffic model combined with a dispersion model to simulate air quality changes near roads, specifically examining the differences between DACs and non-DACs. Our findings reveal that per capita ZEV ownership in non-DACs is 3.8 times higher than in DACs. Additionally, black, indigenous, and people of color (BIPOC) residents own fewer ZEVs regardless of their community's DAC designation, when compared to their respective population shares. Although DAC residents receive approximately 40% more pollutant reduction due to intercommunity ZEV trips, they continue to be disproportionately exposed to higher levels of traffic-related air pollutants. This disparity highlights the need for more targeted and inclusive ZEV policies that can effectively address the historically unjust pollution burden faced by DAC and BIPOC residents. In conclusion, our research demonstrates that current ZEV adoption trends in California have not yet equitably benefited all communities, particularly those that are disadvantaged or predominantly composed of BIPOC residents. To achieve truly transformative climate mitigation and environmental justice, it is imperative that future ZEV policies take into account the uneven distribution of ZEV ownership and associated air quality benefits.

7DI.3

Environmental Health, Racial/Ethnic Health Disparity, and Climate Impacts of Inter-Regional Freight Transport in the United States. MANINDER THIND, Chris Tessum, Julian Marshall, *University of Washington, Seattle*

Atmospheric emissions from freight transportation contribute to human health and climate damage. In this research, we quantify and compare three environmental impacts from inter-regional freight transportation in the contiguous United States: total mortality attributable to fine particulate matter ($PM_{2.5}$), racial−ethnic disparities in $PM_{2.5}$-attributable mortality, and climate impacts (CO_2 emissions). We compare all major freight modes (truck, rail, barge, aircraft) and routes (~30,000 routes). Our study is the first to comprehensively compare each route separately and the first to explore racial−ethnic exposure disparities by route and mode, nationally. Our analyses use high spatial resolution air quality and health impact model, the Intervention Model for Air Pollution (InMAP) to model pollutant exposure and mortality impacts.

Impacts (health, health disparity, climate) per tonne of freight are the largest for aircraft. Among non-aircraft modes, per tonne, rail has the largest health and health-disparity impacts and the lowest climate impacts, whereas truck transport has the lowest health impacts and greatest climate impacts – an important reminder that health and climate impacts are often but not always aligned. For aircraft and truck, average monetized damages per tonne are larger for climate impacts than those for $PM_{2.5}$ air pollution; for rail and barge, the reverse holds. We find that average exposures from inter-regional truck and rail are the highest for White non-Hispanic people, those from barge are the highest for Black people, and those from aircraft are the highest for people who are mixed/other race. Level of exposure and disparity among racial−ethnic groups vary in urban versus rural areas. This research can be used to inform, for a given origin and destination, which freight mode offers the lowest environmental health, health-disparity, and climate impacts.

7DI.4

Household and Mobility-Influenced Personal PM2.5 Exposures for a Rail-Impacted Environmental Justice Community. Ivette Torres, Khanh Do, Andrea Delgado, Charlotte Mourad, Haofei Yu, CESUNICA IVEY, *University of California, Berkeley*

The Westside San Bernardino neighborhood is a hot spot of air pollution and high rates of cancer, potentially caused by its proximity to a large industrial facility, the largest concentration of warehouses in the country, and multiple freeways. In addition, geography and wind patterns trap and compound port-related pollutants in the inland valleys. More than 270,000 people living in the surrounding area face a higher risk of cancer solely due to where they live. In an effort to provide data-driven evidence to corroborate community members' lived experiences, personal $PM_{2.5}$ monitoring took place from October 2021 through March 2022. We engaged 9-14 community members per week for three weeks at a time. Each participant completed one intake survey to collect demographic and baseline health information, and then each participant completed a dynamic survey at the end of each deployment week to assess perceptions of well-being. Personal monitoring activities indicated a clear trend of higher residential microenvironmental concentrations compared to concentrations in non-residential microenvironments. Additionally, we monitored indoor and ambient $PM_{2.5}$ levels for five households (ten total households for ambient monitoring) over six months. Our analysis showed that household $PM_{2.5}$ levels had a higher-than-expected average infiltration factor compared to crowdsourced studies. Also, approximately 33% of the time, indoor $PM_{2.5}$ levels were greater than ambient $PM_{2.5}$ levels due to high frequent indoor emissions or less-than-optimal ventilation. The indoor 98th percentiles across the households far exceeded the 24-hour NAAQS. We recommend continued indoor air quality monitoring, and we support emissions and exposure mitigation efforts that address nearby historical pollution burdens.

7DI.5

Ozone Exposure Disparities in Future Low-Carbon Emissions Scenarios in Southern California. Yusheng Zhao, Yiting Li, Yin Li, Anikender Kumar, MICHAEL KLEEMAN, *University of California, Davis*

Adoption of low-carbon energy will reduce emissions of primary particulate matter (PM) and oxides of nitrogen (NOx) but may increase concentrations of ambient ozone (O3) in locations that currently experience NOx-rich chemistry. For example, previous studies have shown that the adoption of low-carbon energy sources in Southern California will increase the predicted O3 concentrations in the year 2050, violating the O3 National Ambient Air Quality Standards (NAAQS). Anticipating these problems and designing strategies to minimize these unintended consequences is a necessary step in the planning process for California’s transition to low-carbon fuels.

Here we explore supplemental emissions control strategies in Southern California that reduce O3 concentrations in the presence of low-carbon energy adoption and we evaluate how these strategies affect O3 and NO2 exposures for different race and ethnicity groups. Air quality simulations are conducted using the University of California Davis/California Institute of Technology (UCD/CIT) air quality model coupled with a newly developed O3 source apportionment technique. Ozone source apportionment results are used to guide the design of supplemental emissions control strategies. Five different emission scenarios are evaluated: a Business-As-Usual (BAU) scenario, a greenhouse gas mitigation (GHGAi) scenario, and three supplemental emission reduction scenarios that build on the GHGAi scenario. Each emissions option is evaluated over 32 weeks selected between the years 2046 through 2055 in order to capture ENSO variability in meteorological conditions. Population exposure to total O3 and different sources of O3 is calculated for different races and ethnicity groups. The ability of each emissions strategy to reduce exposure disparities is evaluated, and recommendations for future controls will be discussed.

7DI.6

Fine Particulate Matter Disparities in Kansas City, MO, are Significant and Persist Across the Past Decade. Shreeram Ojha, AMY CHRISTIANSEN, *University of Missouri - Kansas City*

The Midwestern city of Kansas City, MO, has a long history of redlining practices beginning in the 1920s that have deeply segregated the city. This segregation persists to the present day, making Kansas City an important place to study pollution disparities along demographic lines. Here, we examine quantitative decadal trends and seasonal patterns in air pollution disparities in the Kansas City Metropolitan Area (KCMA) using Census tract demographic information from the United States Census Bureau and daily fine particulate matter (PM2.5) mass concentrations from both existing ground monitoring stations and the Environmental Protection Agency’s Downscaler Model from 2009 to 2019. We find statistically significant ($p<0.05$) differences in PM2.5 distributions between predominantly white communities and communities of color that persist through all seasons and throughout the past decade. These significant differences persist throughout the PM2.5 distribution, including the 5th, 50th, and 95th percentiles. While disparities in PM2.5 mass concentrations are persistent throughout all seasons, we find that the largest discrepancies occur during summer and fall. On an annual basis, we find that communities of color have experienced on average >1 µg m-3 (10%) higher PM2.5 burden than predominantly white communities over the past decade. Despite overall decreasing PM2.5 mass concentrations, the disparity between communities remains remarkably consistent over time, indicating that the pollution gap between communities has not been narrowed by emissions regulations. Here, we also discuss the weekday/weekend impact on PM2.5 disparities and concentrations, as well as a preliminary analysis to attribute tract-level PM2.5 disparities to specific source sectors.

7IA.1

Evaluation of Long-Term Changes in HVAC Filtration Efficiency and Airflow Resistance: Implications for Indoor Aerosol Concentrations and Building Energy Consumption.

Chunxu Huang, Nusrat Jung, BRANDON E. BOOR, *Purdue University*

HVAC filters are an effective strategy for reducing aerosol concentrations in buildings. They can protect building occupants from exposure to aerosols of indoor and outdoor origin. The filtration efficiency and airflow resistance (pressure drop) of HVAC filters can change and evolve during their service life in commercial and residential HVAC systems. However, the performance of HVAC filters is primarily evaluated at their initial, un-aged state. In this study, long-term changes in size-resolved filtration efficiencies and airflow resistances of HVAC filters were evaluated over two years of continuous ageing under 100% outdoor air. A HVAC filter test rig was custom designed and built to age three HVAC filter banks with pre- and final-filters at a constant volumetric airflow rate of 2000 ft^3 min^{-1} (3400 m^3 h^{-1}). Particle number size distributions from 10 nm to 10 µm were measured across each pre- and final-filter using a scanning mobility particle sizer (SMPS) and an optical particle sizer (OPS) connected to an automated valve switching system. The natural filter ageing experiment began in November 2020 and concluded in January 2023. The pre-filters were changed in January 2022. The pre-filters (all MERV8) and final-filters (MERV8, MERV13, MERV14) exhibited unique temporal trends in their performance over the two year ageing process. The pleated MERV8 pre-filters exhibited large increases in pressure drop, whereas all three final-filters exhibited comparatively smaller or negligible increases in airflow resistance. The MERV8 pre-filters became more efficient over time, while the electrostatic bag MERV13 final-filter became less efficient and the V-cell MERV14 final-filter showed no noticeable change in efficiency. The results demonstrate that initial testing of HVAC filter performance may be insufficient to predict long-term changes due to ambient aerosol loading. Temporal changes in HVAC filtration efficiency and airflow resistance over months to years must be considered in modeling indoor aerosol concentrations and HVAC blower energy consumption.

7IA.2

Effectiveness of In-Duct Ionization in a Real-World Lecture Hall.

DAVID KORMOS, Nishit Shetty, Linsey Marr, *Virginia Tech*

Ionization technology has been proposed as a potential solution for reducing airborne bacterial contamination. In this study, we aimed to determine the effectiveness of in-duct ionization in reducing the culturable bacterial load in a large lecture hall. To achieve this, we monitored the airborne bacterial concentration in the room when the ionizer was off and when it was on. We used two types of portable samplers at the front, center, and back of the room simultaneously. We sampled 12 m^3 of air at each location with an ACD-200 Bobcat for analysis of total bacteria by quantitative polymerase chain reaction (qPCR), and we collected 1 m^3 of air at each location onto gelatin filters with a Sartorius MD8 Airport for determination of colony forming units. Preliminary results revealed that culturable bacteria were detected in both the ionizer-off and ionizer-on conditions, and differences in bacterial counts between the two conditions were not significant. Additionally, differences in total bacterial concentrations in terms of copies of the 16S rRNA gene were also not significant. These results suggest that in-duct ionization alone may not be sufficient to eliminate airborne bacterial contamination in a large lecture hall.

7IA.3

Performance of Portable Air Cleaners in Reducing Particulate Matter in Real-World Application Scenarios. Frederic T. Lu, Robert Laumbach, Alicia Legard, Nirmala Thomas Myers, Kathleen Black, Pamela Ohman-Strickland, Shahnaz Alimokhtari-V, Adriana De Resende, Leonardo Calderón, GEDIMINAS MAINELIS, Howard Kipen, *Rutgers, The State University of New Jersey*

There is an increased interest in applying portable air cleaners (PACs) with HEPA filters to reduce indoor particulate matter (PM), including infectious viruses and bacteria. Meanwhile, the performance of PACs in naturalistic settings and in indoor spaces beyond the room containing the PAC (i.e., secondary rooms) is not well characterized. Here we report on the effectiveness of a PAC in reducing PM levels in both primary and secondary rooms and the impacts of central air systems on PAC performance.

We conducted a single-blinded, randomized, cross-over interventional study in the homes of 29 adults who tested positive for COVID-19. PACs with HEPA installed (“filter” state) were operated for 24 hr, while PACs operated with the filter removed (“sham” state, i.e., control) for 24 hr served as controls. The treatment order was randomized. The PM2.5 and PM10 concentrations were measured in real time in the room containing the PAC (i.e., primary room) and the room without a PAC (i.e., secondary room) using AirVisual Pro nodes (IQAir, Goldach, Switzerland). The effectiveness of the PACs was calculated as the percent reduction in mean PM concentrations during the filter state. Significance testing was by Wilcoxon signed rank test.

PAC effectiveness in reducing PM concentrations was 66.1% (n=26) for both PM2.5 and PM10 fractions in primary rooms and 13.9% and 25.0% (n=23), respectively, in secondary rooms. PAC-associated PM reductions were enhanced to approximately 80% in primary and 65% in secondary rooms when a central air handler was used.

Overall, we found that PACs substantially and significantly reduced PM2.5 and PM10 concentrations in primary rooms during 24 hr of operation. PM concentrations in secondary rooms were also reduced. Central air handlers seemed to potentiate the effectiveness of PACs in primary rooms and, to a lesser extent, in secondary rooms.

7IA.4

Variability in Indoor Dust Surface Concentrations and Size Distributions among Urban and Suburban Homes in the U.S. SATYA PATRA, Brian Magnuson, Iane Gomes, Laura Ajala, Paige Thompson, Orit Herzberg, Meghan Kalvey, Emily Halpern, Alexander Laskin, Laura Claxton, Karen Adolph, Brandon E. Boor, *Purdue University*

Infants can be exposed to environmental toxicants in indoor dust via ingestion and inhalation. Dust ingestion can occur following particle contact transfer between indoor surfaces and mouthed objects and dust inhalation can occur following infant movement-induced particle resuspension. Both contact transfer and resuspension are dependent on the physical characteristics of indoor dust. The aim of this study is to investigate how home and demographic factors influence indoor dust surface concentrations and size distributions to better predict early-childhood exposure to dust-bound toxicants. Indoor dust was collected from urban homes in New York, NY and suburban and rural homes in West Lafayette, IN using a standardized vacuum-based collection method. Home video tours and parent-report questionnaires were used to collect information on home and demographic factors that may influence the presence and amount of indoor dust. Indoor dust samples were sieved, weighed, and analyzed via a laser diffraction particle sizer. Suburban and rural homes had higher indoor dust surface mass concentrations (mean: 3.9 (±0.9) g m^{-2}) compared to urban homes (mean: 2.7 (±0.9) g m^{-2}). Entryways exhibited the highest surface concentrations across both locations (mean: 8.7 (±1.7) g m^{-2}), followed by living/family rooms (mean: 3.2 (±0.8) g m^{-2}) and bedrooms (mean: 2.6 (±1.0) g m^{-2}). Furthermore, the type of indoor flooring influenced dust surface concentrations, with the highest levels found on area rugs (mean: 5.2 (±1.7) g m^{-2}), followed by carpets (mean: 4.2 (±0.8) g m^{-2}), and considerably lower surface concentrations on hardwood flooring (mean: 0.3 (±0.1) g m^{-2}). Indoor dust surface volume size distributions spanned from approximately 1 to 1,000 µm and commonly featured two prominent modes: one between 10 and 30 µm and another between 80 and 120 µm. The implications of the variability in indoor dust surface concentrations and size distributions on infant exposures will be discussed.

7IA.5

Chemical and Toxicant Analysis of House Dust in Urban Versus Suburban Areas. EMILY HALPERN, Killian MacFeeley, Lauren Heirty, Maria Misovich, Christopher P. West, Satya Patra, Brian Magnuson, Brandon E. Boor, Paige Thompson, Laura Claxton, Orit Herzberg, Meghan Kalvey, Karen Adolph, Alexander Laskin, *Purdue University*

House dust is a complex environmental sink for indoor aerosols and gases that may have health impacts in infants due to inhalation and ingestion. Indoor aerosol and deposited house dust can contain environmentally persistent free radicals (EPFR), heavy metals, and persistent organic pollutants which are of concern for infant development. The composition of house dust also differs depending on home location, building characteristics, and socioeconomic factors. Here, we investigated the composition of sieved house dust samples collected from households with infants (6-24 months) in West Lafayette, IN (and surrounding areas) and in New York, NY. A host of complementary multi-modal analytical techniques are applied to determine the presence and concentration of species of concern. We employ electronic paramagnetic resonance spectroscopy to characterize radical type and quantify EPFR concentrations. To characterize heavy metal composition, we employ a combination of x-ray fluorescence spectroscopy and inductively coupled plasma-mass spectrometry (ICP-MS) measurements. The quantitation of heavy metals using ICP-MS is performed for toxic and commonly found metals (Fe, Pb, As, Cu, Al, Cr, Ni). The molecular characterization of persistent organic pollutants is achieved using solid phase extraction followed by analysis with ultrahigh performance liquid chromatography equipped with a photodiode array detector and high-resolution mass spectrometry interfaced with both electrospray ionization and dopant-assisted atmospheric pressure photoionization. Through these methods, we observe the compositional differences of house dust in different regions, and the concentrations of these species can inform understanding of their impact on infant health.

7IA.6

Particle and Gas-phase Evaluation of Air Cleaners Under Indoor Wildfire Smoke Conditions. BRETT STINSON, Baorong Luo, Aurelie Laguerre, Elliott Gall, *Portland State University*

The number of acres burned each year due to wildfires has grown significantly since 1991. Indoor air cleaning interventions that rely upon high-efficiency particle filters have been proven to reduce exposure to fine particulate matter. However, wildfire smoke emissions include a myriad of hazardous particle and gas-phase constituents; there exists limited testing of air cleaners under the extreme conditions of an indoor space impacted by outdoor wildfire smoke. This study characterized 12 air cleaning devices, experimentally determining their size-resolved particulate matter, volatile organic compound (VOC), and black and brown carbon clean air delivery rates (CADRs), as well as power draw and sound levels. Portable devices that remove pollutants from air via standard HEPA and pre-filters, activated carbon banks, particle charging, and hydrogen peroxide generation were tested, along with three low-cost, do-it-yourself (DIY) configurations comprised of MERV 13 filters affixed to a box fan. The “pull-down” method was employed in triplicate within a large, stainless steel chamber, using pine needle combustion emissions as the challenge aerosol to simulate wildfire smoke. Results show that pine needle smoke PM2.5 CADRs were generally consistent with the smoke CADRs determined by standard test methods, for those air cleaners for which data was available. Two of the DIY configurations proved to be the most effective at removing larger particles (1–2.5 µm), with average CADRs of 1032 and 574 m^3/h, respectively. In contrast with air cleaners that have HEPA filters, particulate matter CADRs for DIY air cleaners decreased with decreasing particle diameter. Among the air cleaners designed to remove gas-phase pollutants via activated carbon, meaningful VOC CADRs were realized, with two devices yielding benzene CADRs in excess of 200 m^3/h. Air cleaners that added reactive species to the air yielded mixed results and warrant further analysis. These results show a variety of air cleaners can meaningfully remove indoor wildfire smoke under a realistic challenge, albeit in controlled conditions. Generally, gas-phase air cleaning yielded, at best, modest CADRs. This, along with substantial variability in PM CADRs across air cleaners indicates the need for further study and thoughtful public messaging regarding selection of air cleaners to comprehensively address indoor exposures to wildfire smoke of outdoor origin.

8AC.1

Effects of Volatility, Viscosity, and Non-ideality on Particle-Particle Mixing Timescales of SOA. MEREDITH SCHERVISH, Manabu Shiraiwa, *University of California, Irvine*

Different populations of aerosol are constantly being mixed throughout the atmosphere, e.g. indoor-to-outdoor mixing, concentrated pollution plumes mixing with ambient aerosol, or simple transport of ambient aerosol from different sources. Large-scale models often represent fast mixing between different aerosol populations relative to other atmospheric processes, due to computational limitations, so that they rapidly form an internal mixture. Previous experiments aimed at probing particle-particle mixing timescales have shown that mixing between different SOA components can be rapid at high RH, but can be hours at low RH. The differences in mixing timescales can be attributed to different volatility distributions, diffusions limitations due to higher particle viscosity at low RH, or non-ideal miscibility. Here we apply the kinetic multilayer model of gas-particle partitioning (KM-GAP) to simulate mixing of two particle populations to probe the complex interplay of mass transfers kinetics and non-ideal thermodynamic partitioning. We simulate that population 1 contains a semi-volatile species that evaporates and re-partitions into population 2 by varying bulk diffusivity and activity coefficient as well as the pure saturation concentration of the semi-volatile species. We found that equilibration timescale is prolonged when the semi-volatile species is favorably miscible in population 2, as more mass needs to move to population 2 at equilibrium. Extremes of volatility prolong the equilibration timescale as low volatility species evaporate slowly from population 1, while high volatility species condense slowly to population 2. When population 1 is liquid, semi-volatile species equilibrate relatively fast for semi-solid population 2 particles, but not for solid particles. We apply the model to experimental mixing experiments to show consistency between measurements of SOA viscosity, SOA miscibility, and observed mixing. We show extremes of volatility, high viscosity, and favorable miscibility lead to long mixing timescales, while semi-volatile species mix rapidly in less viscous particles especially if they have low miscibility.

8AC.2

Measurements of Singlet Oxygen and Organic Triplet Excited States in Aqueous Aerosols in Hong Kong, South China. THEODORA NAH, Yuting Lyu, Yin Hau Lam, Yitao Li, Nadine Borduas-Dedekind, *City University of Hong Kong*

Photooxidants in the atmospheric aqueous phase, such as triplet excited states ($^3C^*$) and singlet oxygen ($^1O_2$), play important roles in the formation and transformation of secondary organic aerosols (SOA). In order to elucidate the importance of these aqueous reactions in SOA formation and transformation, it is necessary to quantify the quantum yields and steady-state concentrations of these aqueous photooxidants. However, measurements of aqueous photooxidants in atmospheric samples are still scarce. In this study, using the chemical probe technique, we show that the illumination of aqueous aerosols in Hong Kong leads to the efficient production of $^3C^*$ and $^1O_2$. Experiments were conducted using PM2.5 and size-fractionated aerosols collected during different seasons in two urban and one semi-rural locations in a year-round study. We observed that $^3C^*$ and $^1O_2$ production were the highest in the winter and the lowest in the summer for all three locations. Differences in the locations (urban vs. semi-rural) did not have noticeable effects on $^3C^*$ and $^1O_2$ formation. The seasonal trends of $^3C^*$ and $^1O_2$ production were observed to be due to seasonal variations in the long-range air mass transport. $[^1O_2]ss$ and $[^3C^*]ss$ were observed to correlate with the concentration and absorbance of water-soluble organic carbon in both PM2.5 and size-fractionated aerosols. We also attempt to correlate $^3C^*$ and $^1O_2$ production to the composition and measurable optical properties of the PM2.5 and size-fractionated aerosols. This is the first investigation of aqueous photooxidant production in atmospheric aerosols in a South China city, and our findings will help the modeling of aqueous organic aerosol photochemistry in the South China region.

8AC.3

Model of a Photochemically Induced Iron-Copper Cycling in Viscous Organic Aerosol. KEVIN KILCHHOFER, Ashmi Mishra, Peter A. Alpert, Thomas Berkemeier, Allan K. Bertram, Markus Ammann, *Laboratory of Atmospheric Chemistry, Paul Scherrer Institute*

Photochemical aging of organic aerosol (OA) particles is an important pathway to generate oxidants and alter atmospheric chemistry. Photolysis of redox-active transition metals such as iron complexed with organic material contributes to aging and changes the oxidative potential (OP) of OA as well as their atmospheric fate. Based on this, we evaluate poorly characterized iron chemistry interacting with other transition metals such as copper. We conducted photochemical aging experiments in a coated-wall flow tube with a mixture of citric acid, iron citrate, and copper citrate as a proxy for an atmospherically-relevant OA. Citric acid is considered a proxy compound of secondary organic aerosol material. The aging was performed under irradiation with UV light ($\lambda = 345$ nm) as a function of relative humidity (RH). We measure volatilized CO2 as the first decarboxylation product of citric acid to quantify the rate of photochemical cycling and to constrain the kinetic multi-layer model of aerosol surface and bulk chemistry (KM-SUB[1]). The model is employed to gain an understanding of the interplay of physical and chemical processes, i.e., reaction and diffusion, in the multiphase chemical system. The model results show that bulk diffusion of oxygen is a very sensitive parameter implying a strong limitation of the reaction kinetics by molecular transport, suggesting a highly-viscous organic matrix. We implemented an iron-copper catalytic redox cycling mechanism[2–4] intending to better understand the influence of trace metals in the radical chemistry of OA. To support the kinetic model calculations, we aim for calculating bulk diffusion coefficients of different species as a function of RH based on viscosity measurements of our aerosol proxies with poke-flow and fluorescence recovery after bleaching experiments[5,6]. This work uniquely includes possible redox reactions between iron and copper complexes, which may elucidate the role of photochemically active OA in the atmosphere.

8AC.4

Constraining RO2 Fate in Environmental Chambers: A Systematic, Model-Informed Approach for Laboratory Studies of SOA Formation. HANNAH KENAGY, Matthew Goss, Nadia Tahsini, Colette L. Heald, Jesse Kroll, *Massachusetts Institute of Technology*

Many of the quantitative descriptions of secondary organic aerosol (SOA) formation in regional and global models are derived from environmental chamber experiments, an experimental approach commonly used to assess multi-phase product distributions from atmospheric oxidation pathways. As such, model accuracy for predicting aerosol abundance hinges on the atmospheric relevance of laboratory experiments. In addition to matching the physical conditions of the atmosphere, atmospherically relevant laboratory studies of SOA formation must also match the fate of organic peroxy radicals (RO_2) in the atmosphere. However, matching the distribution of both bimolecular (reaction with HO_2, NO) and unimolecular (isomerization) pathways for RO_2 in environmental chambers to the respective distributions in the global atmosphere is non-trivial because of constraints inherent to laboratory experiments. Here, we systematically explore the parameters available in typical chamber experiments and determine how the distribution of bimolecular and unimolecular RO_2 fates accessible in the laboratory overlaps with RO_2 fates in the chemical environments of the atmosphere. Our approach uses modeling of RO_2 fates on multiple scales: detailed modeling of chamber chemistry with the Master Chemical Mechanism (MCM) in the Framework for 0D Atmospheric Modeling (F0AM) and global modeling using GEOS-Chem. We show that achieving conditions for SOA laboratory experiments in which the distribution of bimolecular and unimolecular RO_2 reaction pathways matches those of the global atmosphere is challenging but achievable with a careful, systematic approach.

8AC.5

Implications of RO2 Fate for α-Pinene SOA Volatility and Composition. ERIK HELSTROM, Lesly Franco Deloya, Hannah Kenagy, Manjula Canagaratna, Jesse Kroll, *MIT*

The formation and composition of secondary organic aerosol (SOA) is governed by the atmospheric processing of volatile organic compounds (VOCs), with a key branch point being the fate of organic peroxy (RO_2) radicals. Laboratory chamber studies have been employed to interrogate the chemistry of SOA formation from the oxidation of many common VOCs under different environmental conditions. However, limits in both chamber conditions and instrumentation have historically pushed experimental design towards higher concentrations of both reactants and oxidants, inhibiting recently-identified RO_2 unimolecular pathways. The impacts of competition between RO_2 isomerization, RO_2+NO, and RO_2+HO_2 reactions on both particle composition and volatility have not been systematically explored. Using explicit chemical modeling to predict likely experimental RO_2 fates, we generate SOA from α-pinene in a series of chamber experiments where the relative abundances of OH, NO, and HO_2 radicals were manipulated to modify the prevailing RO_2 regime. The particles were sampled through a Thermal Denuder–Aerosol Mass Spectrometer (TD-AMS) in order to determine the amount, elemental ratios, and volatility distribution of aerosol as a function of RO_2 fate. Species level chemical information was collected using an Extractive Electrospray Ionization Time of Flight Mass Spectrometer (EESI-ToF-MS) to track SOA compositional variation. Accessing a more atmospherically relevant span of RO_2 fates in the laboratory invites the possibility of describing a range of SOA chemistry beyond the previous “high-NO_x vs. low NO_x” paradigm, to include environmental conditions in which RO_2 isomerization can become competitive with bimolecular RO_2 reactions.

8AC.6

Acyclic Monoterpenes Do Not Suppress Secondary Organic Aerosol Formed via Photooxidation of Cyclic Monoterpenes. SIJIA LIU, Celia Faiola, Sergey Nizkorodov, *University of California, Irvine*

The goal of this work was to investigate cross-coupling reactions occurring during photooxidation of mixtures of acyclic and cyclic monoterpenes, which are commonly co-emitted by biosphere. The hypothesis was that the presence of an acyclic monoterpene would suppress SOA formation from cyclic monoterpenes, similar to the effect previously observed in mixtures of cyclic monoterpenes and isoprene. To test this hypothesis, SOA was prepared in a smog chamber using mixtures representing a range of reactivity ratios of myrcene and d-limonene while maintaining a constant overall OH reactivity. The chemical composition of gas-phase SOA precursors was analyzed using proton-transfer reaction time-of-flight mass spectrometry (PTR-ToF-MS) and thermal desorption–gas chromatography–mass spectrometry (TD-GC-MS). Offline ultra-high-performance liquid chromatography coupled to high-resolution mass spectrometry (UHPLC-HRMS) was used to determine the composition of SOA particles. Viscosity and volatility of SOA were predicted using formula-based parametrizations. Our results did not confirm the initial hypothesis. Firstly, the particulate products of myrcene photooxidation exhibited less fragmentation during photooxidation compared to those from d-limonene, contrasting with a previous ozonolysis study where the opposite trend was observed. Secondly, we did not detect any significant cross-reactions between limonene and myrcene oxidation products. Indeed the observed mass spectra of SOA from the mixtures could be accurately predicted as a linear composition of SOA from individual VOCs. To further understand these unexpected results, we will use the GECKO-A model for detailed mechanism analysis. Our findings suggest that previous observations of SOA suppression by isoprene cannot be extended to larger acyclic terpenes.

8AC.7

Reevaluating Isoprene Oxidation Pathways and Their Influence on Secondary Organic Aerosol Formation.

CHUANYANG SHEN, Haofei Zhang, *University of California, Riverside*

Isoprene is the largest global non-methane hydrocarbon emission, and the chemical reactions of isoprene with atmospheric oxidants play a crucial role in the formation of secondary organic aerosols (SOA), particularly under low-NOx conditions. Two primary pathways contribute to SOA formation from isoprene low-NOx OH oxidation: (1) the production of low-volatility compounds through OH oxidation of intermediates such as ISOPOOH (LV pathway) and (2) the reactive uptake of isoprene epoxidiol (IEPOX) on acidic or aqueous particle surfaces, resulting in the formation of 2-methyltetrols and organosulfates (IEPOX pathway). In this study, we develop a condensed gas-phase chemical mechanism for isoprene oxidation based on the most recent observation-constrained chemistry, and update the zero-dimensional F0AM-WAM model to predict SOA formation from both pathways under chamber and field conditions. We applied our revised isoprene mechanism in simulating chamber studies to evaluate its performance against existing mechanisms by comparing simulations to the observed SOA data. Modeling of the Southern Oxidant and Aerosol Studies (SOAS) field measurements using F0AM-WAM indicate that low-volatility compounds contribute to isoprene SOA more significantly than previously thought, with the modeled SOA mass ratio from the LV pathway of 10-15%, with the rest from the IEPOX pathway. Our findings emphasize that the mass yield from the LV pathway should be considered to enhance the accuracy of model estimations for isoprene SOA formation. The new condensed isoprene chemical mechanism will be further incorporated into regional-scale air quality models, such as the Community Multiscale Air Quality Modelling System (CMAQ), to assess the influence of the LV pathway on a larger scale.

8ES.1

In Memoriam of Astrid Kiendler-Scharr and Her Contribution to Atmospheric Science and Aerosol-Ecosystem Interactions.

GEORGIOS GKATZELIS, *IEK-8: Troposphere, Forschungszentrum Jülich GmbH*

In memory of Prof. Astrid Kiendler-Scharr, this abstract reflects on her significant contributions to atmospheric science and aerosol-ecosystem interactions. Kiendler-Scharr was a renowned researcher and leader in atmospheric chemistry who made groundbreaking contributions to the understanding of the complex interplay between atmospheric aerosols and ecosystems. Her work on the chemical composition and formation mechanisms of aerosols, as well as their impact on climate and air quality, has left a lasting impact on the field of atmospheric science. Kiendler-Scharr was also known for her dedication to fostering the next generation of scientists and her commitment to public outreach, making science accessible to a wider audience. Her passing is a great loss to the scientific community, but her legacy will continue to inspire and influence researchers for years to come.

8ES.2

Aerosolized Harmful Algal Blooms: Distinct Toxins and Congeners Quantified in the Atmosphere. Jia Shi, Nicole Olson, Johnna Birbeck, Rebecca Parham, Jin Pan, Nicholas Peraino, Andrew Holen, Isabel Ledsky, Stephen Jacquemin, Linsey Marr, David Schmale, Judy Westrick, ANDREW AULT, *University of Michigan*

Cyanobacterial harmful algal blooms (cHABs) have the potential to adversely affect public health through the production of toxins, such as microcystins, which consist of numerous molecularly-distinct congeners. cHAB toxins have been observed in the atmosphere after emission from freshwater lakes, but little is known about the health effects of inhaling these toxins and factors contributing to their aerosolization. This word discusses quantification of microcystin congener and other toxin concentrations in water and aerosol samples collected around Grand Lake St. Marys (GLSM), Ohio. Concentrations in water ranged from 13-110 µg/L, with microcystins dominated by the D-Asp3-MC-RR congener. In particulate matter ≤2.5 µm (PM2.5), microcystin concentrations up to 156 pg/m^3 were detected; the microcystins were comprised primarily of D-Asp3-MC-RR, with additional congeners (D-Asp3-MC-HtyR and D-Asp3-MC-LR) observed during periods of elevated wind speeds. The PM size fraction containing the highest MC concentrations ranged from 0.44 to 2.5 µm. Aerosolized bacterial 16S rDNA using qPCR, were observed in samples (≤3 µm) with concentrations up to 9.4×10^4 gc/m^3. Concentrations of aerosolized microcystins varied even when concentrations in water were relatively constant, demonstrating the importance of meteorological conditions (wind speed and direction) and aerosol generation mechanism(s) (wave breaking, spillway, aeration systems) when evaluating inhalation exposure to microcystins and other toxins, along with their subsequent impacts on human health.

8ES.3

Revealing the Composition and Potential Ecological Impacts of Airborne Bacterial Communities in Dust Plumes of the Eastern Mediterranean. YINON RUDICH, Burak Adnan Erkorkmaz, *Weizmann Institute, Rehovot 76100 Israel*

Our understanding of how bacterial communities are transported in the atmosphere is limited. Here, we investigated the key factors affecting the transport of airborne bacterial communities by dust plumes in the Eastern Mediterranean. DNA and RNA extracted from collected aerosols of different sizes and origins were quantified using qPCR and high-throughput amplicon sequencing of 16 S ribosomal RNA gene and transcripts. Our results reveal that the richness and diversity of airborne bacterial communities vary according to air mass origin and particle size. Bacterial abundance, alpha diversity, and species richness were higher in air mass originating from the deserts compared with marine-influenced air masses and were also higher in the coarse particle fraction compared to the fine fraction, suggesting that airborne bacteria are attached to the dust particles or transported as cell aggregates. We identified some dominant bacteria, which have high rRNA abundance, suggesting that these taxa may have been viable in the source environment or during atmospheric transport. Some species of these genera are known to be human, animal, or plant pathogens. Therefore, their presence in the dust samples highlights the potential ecological impact of aerial bacterial transport. We will also discuss our current study, which focuses on metagenomics approaches to investigate the dissemination of potentially pathogenic microorganisms, antibiotic-resistant genes, and virulence factors by dust storms and their potential ecological impacts.

8ES.4

Exploring Aerosol-Climate Interactions over the Benguela Upwelling Zone: A Multifaceted Analysis of DMS Emissions, Aerosol Composition, and Climate Implications. MASHIAT HOSSAIN, Hannah Horowitz, Rebecca Garland, *University of Illinois at Urbana-Champaign*

The west coast of southern Africa features complex interactions among land, atmospheric, and oceanic components. The diverse aerosol composition along with persistent stratocumulus clouds contribute to significant uncertainties in aerosol radiative forcing and climate sensitivity. While previous research focused on biomass burning during the austral dry season due to its substantial regional aerosol load, it is imperative to examine ocean-atmosphere linkages to predict future climatic trends. Coastal upwelling in the Benguela region supports high phytoplankton production with seasonal blooms generating aerosol precursors such as dimethyl sulfide (DMS). This study explores the intricate relationships among phytoplankton activity, DMS emissions, and aerosol composition, considering seasonal variations for a holistic understanding of the system. Furthermore, the work primarily aims to elucidate the key chemical components, such as sulfate aerosols and sea-salt particles, which potentially contribute to aerosol-cloud interactions within the upwelling region. To achieve this, we employ the GEOS-Chem global three-dimensional chemical transport model within a high-resolution (~50 km) one-way nested grid over the SE Atlantic and Southern Africa. Analysis of the vertical aerosol composition over the ocean uncovers a higher sulfate mass in September compared to January, despite a higher percentage composition during January, which coincides with peak DMS emissions. Conversely, aerosol composition in September is predominantly characterized by total organic aerosols, likely from biomass burning. We perform sensitivity analyses to assess the uncertainty in aerosol composition due to DMS chemical mechanisms and marine primary organic aerosol emissions. Satellite-derived coccolithophore index is used to estimate the impact of uncertainty in DMS emissions. We evaluate modeled aerosols against aircraft campaigns and long-term monitoring stations. This research will contribute to advancements in the parameterization of ocean-atmosphere coupling, refining the representation of marine aerosols in atmospheric models linked to phytoplankton characteristics.

8ES.5

Modeling the Dispersal Kernel Across Scales: Local Validation and Regional Insights into Seasonal Patterns and Spatial Variability. MANU NIMMALA, Hope Gruszewski, Regina Hanlon, Landon Bilyeu, Tyler Newton, David Schmale, Shane Ross, Hosein Foroutan, *Virginia Tech*

Dispersal patterns of bio-aerosols like spores, seeds, and pollen are essential for studying the spread of plant diseases, gene flow, and cross-pollination. The dispersal kernel gives the probability of particle deposition as a function of distance from the source, and is highly dependent on meteorological conditions. For example, the movement of particles from local to regional scales is influenced by the balance between shear and convective turbulence. Lagrangian Stochastic (LS) models effectively capture this balance by using random walks to simulate particle trajectories. An ensemble of these trajectories forms a dispersal kernel. In this study, we use LS models to simulate dispersal kernels spanning local and regional scales, ranging from a few meters to 100 km away from the source. We first evaluate two LS model formulations – one for the surface layer and the other for convective conditions – against near-source, ground-level concentration measurements from a recent switchgrass field experiment in Tennessee. Following this local-scale validation study, we extend the model domain for a regional-scale application. Inspired by cross-pollination concerns in the emerging US hemp industry, we use LS modeling to simulate the dispersal kernel of hemp pollen for each US county. We drive the model using hourly data from a 2016 Weather Research and Forecasting (WRF) simulation over the contiguous US. The resulting dispersal kernels show seasonal and spatial patterns, revealing seasonal shifts in areas of the country more prone to long-distance dispersal. To the best of our knowledge, this is the first simulation study investigating the inhomogeneity of pollen dispersal across regions and seasons. Although we discuss pollen specifically, the methods used are general and could apply to dispersal of any light particle. Overall, this work contributes experimental data and model validation at local scales, and furthers understanding of how regional-scale dispersal kernels change with weather conditions.

8ES.6

Atmospheric Reactivity and Aerosol Formation from Observed Versus Modeled BVOCs in a Southeastern US Forest. NAMRATA SHANMUKH PANJI, Deborah F. McGlynn, Laura E. R. Barry, Xi Yang, Manuel Lerdau, Todd Scanlon, Sally Pusede, Gabriel Isaacman-VanWertz, *Virginia Tech*

A vast number of reactive organic gases are continuously emitted into the atmosphere and ultimately lead to increased global organic aerosol (OA) burden through complex photochemical oxidation pathways. MEGAN (Model of Emissions of Gases and Aerosols from Nature) is a widely used model that estimates emissions of such reactive biogenic volatile organic compounds (BVOCs) from terrestrial vegetation. However, using long-term measurements at a forested site in the southeastern U.S., our group has demonstrated that global emissions models do not capture observed spatial and temporal trends in the concentrations of key BVOCs that impact atmospheric chemistry. With three years of hourly measurements of BVOC mixing ratios, ozone fluxes, meteorological and ecological data at the Virginia Forest Laboratory (VFL), we compare observed and modeled trends of BVOC concentrations on different temporal scales: hourly, diurnal, seasonal, and yearly. We explore the sensitivity of the models to different meteorological and ecological conditions for further modifications of current emission models. By coupling emissions estimates with the Framework for 0-D Atmospheric Model (F0AM) we examine how these differences produce downstream atmospheric impacts, for example due to shifts in atmospheric reactivity and differences in the fates of the products formed by major BVOCs. We consider how first-generation products produced by monounsaturated monoterpenes (e.g., pinenes) are more likely to deposit compared to products of more reactive isomers, and thus may have lower aerosol yields than expected.

8IA.1

Autoxidation of Glycols Used in Inhalable Daily Products: Implications to the Use of Artificial Fogs and E-cigarettes. XINYANG GUO, Ya-Chun Chan, Tania Gautam, Ran Zhao, *University of Alberta*

With the expansion of the entertainment and vaping industries, many workers and consumers have experienced various adverse health effects from poor indoor air quality (IAQ). Inhalable glycols are common chemicals used in these industries. Although the ingestion of glycols is considered safe, inhalation risks associated with glycols are not well understood. Our previous work has highlighted a rapid accumulation of formaldehyde and glycolaldehyde in artificial fog on the stage, thus proposing the occurrence of glycol autoxidation. However, chemical processes causing carbonyl formation and their implications for consumer and occupational health remained poorly understood.

This work is aimed to monitor the autoxidation process of glycols during storage. More specifically, a systematic study on the intermediate and the product autoxidation will be performed. The effect of storage conditions and the composition of the solution will be evaluated, for instance, air exposure and water mixing ratio. Lastly, the effectiveness of antioxidants will also be explored.

Our previous results recognized that triethylene glycol (TEG) is the major source of toxic carbonyls in fog juice. Hence TEG is predominantly investigated for the fundamentals of autoxidation. Other common glycols, such as glycerol, propylene glycol, diethylene glycol, and e-juice are also involved. Carbonyls were quantified using liquid chromatography-mass spectrometry (LC-MS), and peroxides from autoxidation were monitored via iodometry and UV-Vis spectrometry. By monitoring the aging of glycols, a formation of formaldehyde and glycolaldehyde was observed in all glycols. We confirmed that air exposure is the driving force of autoxidation. The water mixing ratio of the glycol also matters as a water ratio of up to 50% is accelerating the reaction. Additionally, vitamin C has effectively minimized autoxidation despite the storage condition. Our results provided a detailed investigation of glycol autoxidation, suggesting that improper storage of inhalable glycols is significant for indoor carbonyl exposure.

8IA.2

Ozonation of Tobacco Smoke Contaminants Embedded in Indoor Deep Reservoirs.

XIAOCHEN TANG, Nicolas Lopez-Galvez, Vi Rapp, Penelope Quintana, Hugo Destaillats, *Lawrence Berkeley National Laboratory*

Carpets represent approximately 50% of the US residential flooring market. In environments where smoking takes place regularly, carpets and other materials can become severely contaminated with thirdhand tobacco smoke (THS), leading to exposures by inhalation, dust ingestion and dermal contact. In this study, we assessed the efficacy of ozonation as an indoor remediation strategy, by evaluating how carpet serves as a sink and long-term source of THS, while protecting contaminants absorbed in deep reservoirs by scavenging ozone. Specimens from unused carpet that was exposed to smoke in the lab (“fresh THS”), and contaminated carpets retrieved from homes occupied by smokers over the previous 6 to 25 years (“aged THS”), were treated with 1,000 ppb ozone in bench-scale tests. The concentration of nicotine embedded in the carpet specimens was measured before and after the ozone treatment. Nicotine was partially removed from fresh THS specimens by volatilization and oxidation, but it was not significantly eliminated from aged THS samples. By contrast, most of the 24 polycyclic aromatic hydrocarbons (PAHs) detected in both samples were partially removed by ozone. One of the home-aged carpets was installed in an 18-m^3 room-sized chamber, where its measured nicotine emission rate was 950 ng day^{-1} m^{-2}. In a typical home, such daily emissions could amount to a non-negligible fraction of the nicotine released by smoking one cigarette. Operation of a commercial ozone generator for a total duration of 156 min, reaching concentrations up to 10,000 ppb, did not significantly reduce the carpet nicotine loading (26 – 122 mg m^{-2}). Ozone reacted primarily with carpet fibers, rather than with THS, leading to short-term emissions of aldehydes and aerosol particles.

8IA.3

Acetal Formation of Flavoring Agents with Propylene Glycol in E-cigarettes: Impacts on Indoor Partitioning and Thirdhand Exposure.

SHUANG WU, Erica Kim, Ran Zhao, *University of Alberta*

The widespread popularity of e-cigarettes has led to a significant increase in teen nicotine use. A large number of flavorings are the main contributors; the most commonly-used agents are carbonyls, which are toxic upon inhalation and may cause lung diseases. In e-cigarette solvents (e-liquids), flavorings can react to form acetals with different chemical properties and unknown toxicologies. Once emitted indoors, these harmful flavorings and their acetals can cause secondhand and thirdhand exposures, defined as exposures occurring through evaporation or chemical partitioning. These processes are governed by partitioning coefficients. The recent discovery of a large volume of indoor reservoirs signifies the importance of indoor partitioning, which is responsible for thirdhand exposure. However, conversions of flavorings to acetals in e-liquids have been rarely identified and their chemical properties are still unknown.

This study focuses on the liquid-phase chemical reactions of flavor carbonyls with e-liquid components, namely propylene glycol (PG). This work is the first to estimate the conversion of α-diketones to acetals in PG. Further, this work aims to understand how acetal formation affects the indoor partitioning of flavor carbonyls. Specifically, proton nuclear magnetic resonance (^{1}H NMR) spectroscopy has been employed to monitor the liquid-phase reaction. Poly-Parameter Linear Free Energy Relationships (ppLFERs) have been used to estimate the partitioning coefficients. A chemical two-dimensional (2D) partitioning model has been applied to predict the indoor phase distribution of flavorings and evaluate the potential pathways of human exposure.

This research provides insights into secondhand and thirdhand exposure to e-cigarette emissions. Indoor partitioning of flavorings added in e-cigarettes is not only determined by flavorings but is also affected by adducts formed in e-liquids. It should be noted that persistent exposure can harm non-smokers without their awareness through various pathways indoors. Our study helps to better understand the potential health hazards caused by flavorings added to e-cigarettes.

8IA.4

Application of Correlation Gas Chromatography and Two-dimensional Volatility Basis Set to Determine the Physicochemical Properties of E-cigarette Aerosol Constituents. LINHUI TIAN, Alexa Canchola, Kunpeng Chen, Ying-Hsuan Lin, *University of California, Riverside*

E-cigarette aerosols contain a complex mixture of many harmful and potentially harmful chemicals. Once released into the environment, they continue to evolve and become a new source of indoor air pollutants that could pose a significant threat to both users and non-users, especially vulnerable populations. However, the current understanding of the physicochemical properties of e-cigarette aerosol constituents, such as vapor pressure or volatility, that govern gas-particle partitioning in the atmospheric environment is limited, making it difficult to estimate the health risks associated with exposure. In this study, we applied the correlation gas chromatography and two-dimensional volatility basis set (2D-VBS) to determine the sub-cooled liquid vapor pressures and volatility at T/K = 298 for commonly reported toxic and irritating e-cigarette aerosol constituents. The vapor pressures ($\ln(p_{298}/p_0$, $p_0 = 101325$ Pa)) of target compounds at 298K were estimated from the linear relationship between the vapor pressure of reference standards and their retention times. Our results showed that $\ln(p_{298}/p_0)$ by correlation gas chromatography had good overall agreement with estimates using the Modified Grain Method (Epi Suite), with the correlation coefficient (R) around 0.84. Using the 2D-VBS method to estimate volatility, fresh e-cigarette aerosols mainly fell into the bins of SVOCs and IVOCs, and their volatility correlated well with both the calculated vapor pressure from correlation gas chromatography (R = 0.80) and the estimated vapor pressure from Epi Suite (R = 0.81). Overall, this study provides a comprehensive analysis of the physicochemical properties of e-cigarette aerosols, which can assist in the interpretation of the dynamic chemical composition and associated health risks of e-cigarette aerosols in the indoor environment.

8IA.5

Oxidative Potential of the Particulate Matter Emitted from Common Household Sources. P. S. GANESH SUBRAMANIAN, Zhuying Dai, Vishal Verma, *University of Illinois Urbana-Champaign*

Oxidative potential (OP) is a metric, which quantifies the ability of particulate matter (PM) to induce oxidative stress in humans and cause adverse health effects. Although people spend over 80% of their time indoors, the OP of PM emitted from indoor sources are largely unknown. We collected PM emitted by commonly used household sources (unscented-candles, scented-candles, incenses, cigarettes, ultrasonic-humidifiers, and essential-oil-diffusers) in a clean-controlled-environmental-chamber and measured their chemical composition and PM emission rates (PER). Three different assays; dithiothreitol (OP_{DTT}), glutathione (OP_{GSH}), and hydroxyl radical generation (OP_{OH}) were used to quantify OP. Finally, we performed an exploratory exposure assessment using this dataset for a representative room volume (50 m^3, 0.7 Air Changes per hour) scenario.

Preliminary results showed that PER was highest for cigarettes (~1400 µg/min), followed by incenses (400-600 µg/min), and lower than 100 µg/min for the other sources. The PER from unscented-candles was substantially higher (~50x) in presence of a wind-draft. Over 75% of the total PM-mass comprised of organic-matter for cigarette and incense emissions, while over 50% consisted of elemental-carbon for unscented-candles in the presence of wind-draft.

Unscented-candle emissions in presence of a wind-draft showed the highest intrinsic OP_{DTT} and OP_{OH}, while OP_{GSH} was highest for cigarette emissions. This higher intrinsic OP_{DTT} and OP_{OH} could be attributed to the high elemental-carbon content of PM emitted from candles during wind-draft. Ultrasonic-humidifier and essential-oil-diffuser emissions had the lowest intrinsic OP_{DTT} and OP_{OH}, but their OP_{GSH} were comparable with the other sources. Experiments are underway for further OP and chemical composition measurements for other indoor sources, such as air fryer, toaster, room freshener, coffee maker and laser printer.

Inhaled mass of $PM_{2.5}$ and subsequent OP exposure, originating from most of these sources exceeded those from ambient $PM_{2.5}$ exposure (assuming ambient $PM_{2.5}$ concentration 7.4 µg/m^3, typically present in North America). Emissions from humidifier fed with tap-water showed the highest inhaled dose of $PM_{2.5}$, OP_{DTT}, and OP_{GSH} exposure amongst all the tested sources. These exploratory results suggest that $PM_{2.5}$ emissions from some of these sources could pose a higher health risk than outdoor emissions in regions with low ambient $PM_{2.5}$ concentrations.

8IA.6

The Most Comprehensive Reports of Cooking Oil Emission Characterizations. MEHDI AMOUEI TORKMAHALLEH, Motahareh Naseri, Mostafa Salmanimojaveri, Tomiris Madiyarova, Nadezhda Ushakova, Karina Yessengaziyeva, Gulnur Sultanova, Enoch Adotey, Farzaneh Jafarigol, Zhaniya Askar, Gulnaz Zhemeney, Drina Alessa Holliday, Seyed Morteza Zamir, Dhawal Shah, *University of Illinois at Chicago*

This 3-year study includes the most comprehensive reports of cooking oil emission characterizations including particle number (1-400 nm), particle surface (1-400nm), black carbon (BC), PM2.5 and gas emission rates in the literature. The present study investigated most of the commetical cooking oils (17 oils) available in the U.S. market including avocado, canola, coconut, corn, olive, peanut, vegetable, grapeseed, hazelnut, macadamia, almond, sunflower, safflower, flux, walnut, pumpkin seed, and sesame using a carefully designed experiment. The oils were heated to reach the temperature of 195-200 oC and the heating continued for 20 minutes over this temperature range. A Scanning Mobility Particle Sizer (SMPS), was utilized to investigate the particle number and surface size distributions in the size range of 1 nm to 400 nm. An AE33 black carbon Monitor, Magee Scientific, together with Rizgard PM low-cost PM monitor (equipped with Planttower sensors) were used to monitor PM concentrations. Aeroqual, New Zealand, gas sensors were employed to measure gas concentrations including methane and formaldehyde. The emission rates were calculated for three different temperature ranges (195-200 oC, 190-195 oC - 185-190 oC) that were beyond the smoke temperatures of the studied oils, and correlations among emission rates, oil temperature and oil smoke temperatures were developed with relatively good R2. Results showed that the highest total PNC emission rate (2-400 nm) for oil temperature above 195oC was registered for peanut oil 5.37×1012 (SD=3.78×1012) particles/min. Canola showed the highest emission rate in the temperature of 190-195 oC and 185-190 oC, equal to 4.55×1012 (SD=3.93×1012) particles/min and 9.65×1012 (SD=7.62×1012) #/min, respectively. Heating sesame oil resulted in the lowest total PNC emission rate in all three temperature ranges. The ranking of the oils in terms of emission rates were quite different with respect of number based and mass based emission rates making it challenging to come up with a recommendation regarding the low emitting cooking oils. However, the final recommendations will be based on the particle surface area.

8IA.7

Indoor and Outdoor Air Quality Impacts of Commercial Kitchen Operations. JENNA DITTO, Leigh Crilley, Melodie Lao, Trevor VandenBoer, Jonathan Abbatt, Arthur W. H. Chan, *Washington University in St. Louis*

Emissions of gas- and particle-phase organic compounds from commercial kitchens impact both indoor and outdoor air quality. These emissions present a major source of occupational exposure for kitchen staff, and when vented outdoors, can also contribute to urban air pollution loadings. We measured chemically speciated volatile organic compounds and particulate matter mass concentrations in a well-ventilated commercial kitchen in Toronto, with real-time measurements covering typical cooking and cleaning operations as well as background periods. Emitted gas-phase organic compounds from cooking were dominated by oxygenated species likely from the thermal degradation of cooking oils. High air change rates (28/hr on average during operating hours) controlled gas-phase concentrations to 2-7 orders of magnitude below their exposure guidelines. Despite these overall low mixing ratios, our measurements during background periods suggest the presence of a strong surface reservoir source of volatile gases to the room. During evening cleaning, signals of chlorinated gases increased by 1.1-9.0 times relative to their levels during daytime cooking despite air change rates still near 20/hr. We observed a concurrent threefold increase in particulate matter concentrations dominated by particles in the PM_{2-5} range. This emphasizes the need for careful consideration of ventilation rates and methods in commercial kitchen environments during all hours of kitchen operation. These high air change rates created an indoor environment with very low pollutant concentrations, but their ventilation to the outdoors is estimated to have contributed a lower limit of 10^2-10^3 tonnes/year of gaseous pollutants (based on the quantified species in this study) and 10^0-10^1 tonnes/year of PM_{10} to Toronto’s local urban atmosphere.

8ID.1

Assessing Ventilation and Filtration Performance to Improve Indoor Air Quality in an Older Educational Building. JIANING BAO, Nigel Kaye, Ehsan Mousavi, Christopher Post, Vincent Blouin, Andrew Metcalf, *Clemson University*

The COVID-19 pandemic has increased awareness for the need for safer building environments regarding indoor air quality (IAQ), especially for high-occupancy environments including schools and colleges. Compared to newer buildings with modern central ventilation systems, older buildings have potentially less effective ventilation systems with respect to ventilation rate and filtration efficiency, which can increase the vulnerability of building occupants to exposure to poor IAQ. Therefore, it is important to understand how effective ventilation systems are in maintaining proper IAQ in older educational buildings.

In this study, we use low-cost sensors to evaluate IAQ by measuring the concentrations of particulate matter (PM) and carbon dioxide (CO_2) at multiple locations in a classroom that has two fan coil units (FCU) serving as its ventilation system. We conducted experiments with point sources of PM and CO_2 in the indoor space. By analyzing the exponential decay of PM and CO_2 concentrations with time, we evaluated the effectiveness of the ventilation and filtration systems in the classroom. While the PM1.0 decay rate increased by adjusting the fan speed of the FCUs from low to high and by adding HEPA filters and do-it-yourself filter box fans, the trends in CO_2 concentration were unaffected by these mitigation measures. To further understand and explore how to improve IAQ in this classroom, we used the measurements to constrain parameters in a box model of the indoor space. The box model revealed the infiltration rate to the space, which controls the trends in CO_2. By simulating real-world scenarios with the model, one can find the optimal mitigation strategies to simultaneously address both PM and CO_2 pollution in an indoor space.

8ID.2

Exploring the Impact of Diffuser Design on Droplet Dispersion in Indoor Spaces. SUNIL KUMAR, Maria King, *Texas A&M University*

Aerosolization of contaminants including respiratory droplets poses a crucial problem for indoor environments of homes, hospitals, vehicles, facilities requiring early decontamination measures to keep the occupants safe. The HVAC systems installed to provide fresh air play a major role in contributing to the spread of contaminants. The number of Air Change Hours required for different indoor environments are standardized by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) for a mandated 6ACH in hospitals. However, the configuration of air distribution in these indoor environments remains at discretion of HVAC engineers and primarily on choice of manufacturer, and owners. This type of diffuser is critical for achieving early decontamination of the indoor environment. This study evaluates the most used diffuser design to understand the development of air flow patterns and their role in dispersing the contaminated sneeze droplets at different ACH. Further analysis of the design shows that the flow vortices are dependent on the interaction of reflected air from different stationary objects including the walls. The droplets trapped in these vortices tend to recirculate along with indoor air and deposit in specific locations or remain aerosolized for a longer time. The probability of risk of spread of infection increases many folds the longer the droplets remain aerosolized. This study offers insight into ventilation design optimization to mitigate pathogen spread.

8ID.3

Use of a Novel Ferret System Indicates Increased Air Exchange is Not Effective in Reducing Influenza Transmission in Close Contact Exposure Scenarios.

NICOLE C. ROCKEY, Valerie M. Le Sage, Meredith Shephard, Andrea French, Herek L. Clack, Anice Lowen, Aaron Prussin II, Linsey Marr, Seema Lakdawala, *University of Pittsburgh*

Airborne transmission of influenza viruses is critical for their epidemiological success. Current experimental systems used to study transmission do not mimic environmental parameters (e.g., air exchange rates, flow patterns) or exposure times in real-world settings. Therefore, results from these traditional systems are likely not representative of the transmission profile in humans. To address this pitfall, we developed a novel transmission setup that better represents a realistic setting and investigated the impact of air exchange rates on transmission events with close contact behaviors, similar to those in childcare settings. In our novel transmission setting, four immunologically naïve recipient ferrets were exposed to a donor ferret infected with 2009 H1N1 pandemic virus (H1N1pdm09) for four hours in a play-based setup. In this novel system, we tested the transmission efficiency of the H1N1pdm09 virus in two different environmental settings: one group with an air exchange rate of ~ 1.3 hr^{-1}, and the other group with a >10 fold higher air exchange rate of ~ 23 hr^{-1}. Air and surface samples were collected at various locations within the exposure area for virus quantification. Influenza virus transmission was assessed through viral titration of ferret nasal washes and seroconversion 14 days post-exposure.

Despite over an order of magnitude difference in air exchange rates, transmission efficiency was 50% (i.e., 4 of 8 recipients infected) at both air exchange rates over two independent replicate studies. Presence of infectious virus or viral RNA in surface samples was similar regardless of air exchange rate. However, as expected, more virus-laden aerosols were detected at the lower air exchange rate. Our findings indicate that in close contact, short duration exposures, air exchange rates do not significantly impact transmission efficiency. Interventions such as masking or physical barriers may prove more effective than increased air exchange when close contact is expected to occur.

8ID.4

On the PM2.5 - Reported Influenza/Influenza-Like Illness Activity Relationship.

T.P. DEFELICE, *Science Systems and Applications, Inc (SSAI)*

Some studies suggest atmospheric particulate matter with diameters 2.5 micron and smaller (PM2.5) may possibly play a role in the transmission of influenza and influenza-like illness (ILI) symptoms. Those studies were predominantly conducted under moderately to highly polluted outdoor atmospheres. We conducted our study to extend the understanding to include a less polluted atmospheric environment. A relationship between PM2.5 and ILI activity extended to include lightly to moderately polluted atmospheres could imply a comparatively more complicated transmission mechanism. We obtained concurrent PM2.5 mass concentration data, meteorological data and reported Influenza and influenza-like illness (ILI) activity for the light to moderately polluted atmospheres over the Tucson, AZ region. We found no relation between PM2.5 mass concentration and ILI activity. There was an expected relation between ILI, activity, temperature, and relative humidity. There was a possible relation between PM2.5 mass concentration anomalies and ILI activity. These results might be due to the small dataset size and to the technological limitations of the PM measurements. Further study is recommended since it would improve the understanding of ILI transmission and thereby improve ILI activity/outbreak forecasts and transmission model accuracies.

8ID.5

A Comparison of Viral Aerosols in Indoor Spaces of Higher Education: Flu Season vs. Non-Flu Season. JING LI, Yifang Zhu, *University of California, Los Angeles*

During the last fall and winter, the US experienced a surge in respiratory infections, with children being infected with the Respiratory Syncytial Virus (RSV), flu cases increasing, and COVID-19 continuing to circulate. The transmission of viral aerosols indoors continues to pose a severe respiratory infectious disease burden to the public. However, there is limited knowledge regarding the distribution patterns of these respiratory particles in common enclosed spaces such as classrooms and conference rooms. Here in this study, we collected 12 air purifier filters from 8 classrooms and 7 air purifier filters from 6 conference rooms at the Center for the Health Sciences (CHS) Building at the University of California, Los Angeles. All air purifiers from Blueair used HEPASilent™ technology, which captures 99.97% of particles as small as 0.1 µm. The filters were installed in early September 2022 before the fall quarter began and collected at the end of March 2023 after the winter quarter ended, overlapping with the flu season and the “tripledemic” of COVID-19, influenza, and RSV infections. Brand new Blueair filters were installed at the time of collection and will be collected again in mid-June 2023 after the spring quarter ends. We will extract and analyze the viral RNA of SARS-CoV-2, influenza viruses, and RSV attached to the dust particles on the air purifier filters. The research will investigate the distribution of these respiratory viruses during flu season and non-flu season and the difference between classrooms and conference rooms. Furthermore, the study will also examine the association between class size and viral aerosol concentrations. The study findings will be valuable in assessing the risk of different airborne respiratory viruses and developing better practices to mitigate exposure to airborne viruses. Ultimately, this will aid in preventing the transmission of respiratory infectious diseases in classrooms and other indoor environments.

8ID.6

A Device for Real-Time Detection of SARS-CoV-2 Aerosols in Built Environments. JOSEPH V. PUTHUSSERY, Dishit Ghumra, Kevin McBrearty, Brookelyn Doherty, Benjamin Sumlin, Amirhossein Sarabandi, Anushka Mandal, Nishit Shetty, Woodrow Gardiner, Jordan Magrecki, David Brody, Thomas Esparza, Traci Bricker, Adrianus Boon, Carla M. Yuede, John Cirrito, Rajan K. Chakrabarty, *Washington University in St.Louis*

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is a strain of coronavirus that cause the coronavirus disease 2019 (COVID-19) pandemic. The virus mainly spreads through respiratory droplets expelled from infected individuals during sneezing, coughing, breathing, and speaking. These virus aerosols can lead to airborne transmission of the disease, as they can linger in the indoor air for several hours. Today, over two years since the start of the pandemic, real-time direct detection of the SARS-CoV-2 virus in the air remains a technological challenge.

Here, we present a proof-of-concept pathogen Air Quality (pAQ) monitor for real-time (5 min time resolution) direct detection of SARS-CoV-2 aerosols. The pAQ monitor comprises a custom-built high flow (~1000 lpm) wet cyclone bioaerosol sampler coupled to a SARS-CoV-2 spike-protein specific llama-derived nanobody based micro-immunoelectrode (MIE) biosensor for real-time detection of SARS-CoV-2 in air. Ambient air is directly sampled using the wet cyclone pre-filled with phosphate-buffered saline (PBS) solution. The virus aerosols enter the wet cyclone through a tangential inlet and get deposited on the inner walls of the cyclone due to the centrifugal forces acting on them. The particle separation efficacy of the wet cyclone determined by computational fluid dynamic modeling showed comparable or better virus sampling performance than commercially available bioaerosol samplers. We tested the MIE biosensor performance using four dominant SARS-CoV-2 virus strains: Washington (WA1), Beta (B.1.351), Delta (B.1.617.2), and Omicron (BA.1) and obtained a limit of detection (LoD) ranging between 6-32 RNA copies/ml. Laboratory testing of the pAQ monitor demonstrated a device virus detection sensitivity of 77-83% and an LoD of 7-35 viral RNA copies/m^3 of air for the different SARS-CoV-2 variants.

Current efforts are underway for simultaneously detecting other airborne pathogens using the pAQ monitor via multiplexing of MIE biosensors with different target-specific nanobodies. The widespread use of such technologies will assist public health officials with implementing prompt infection control measures.

8ID.7

Modeling Respiratory Airborne Particle Transport in a Car Cabin. BO YANG, John Noonan, Andrew Helgeson, *3M Company*

Many taxi drivers, passengers, and ridesharing users were tested positive since the COVID-19 pandemic, which caused by the Coronavirus, SARS-Cov2 and its variants. Studies showed that the virus can be transmitted in a car cabin as respiratory airborne particles. Experimental measurement with portable air purifiers equipped with HEPA filters has been reported to be able to reduce the airborne particle concentrations in various of indoor scenarios. The goal of this study is to predict the performance of using portable air purifiers in a car cabin. A computational fluid dynamics (CFD) model coupled with aerosol dynamics was built. The air purifier locations were investigated. The plexiglass shields impact on the flow filed and particle trajectories were analyzed. Our findings indicate that the air purifier location is important, and the plexiglass shields could capture large particles (diameter > 100 µm), but they may decrease the air purifier performance.

8IM.1

Extending the Spider-MAGIC Sizing Range for the Detection of Nucleation Mode Particles. STAVROS AMANATIDIS, Gregory S. Lewis, Steven Spielman, Susanne Hering, *Aerosol Dynamics Inc.*

The Spider-MAGIC is a compact, dual-polarity scanning mobility spectrometer that consists of the radial-flow “Spider” Differential Mobility Analyzer (DMA) and the “MAGIC” water-based Condensation Particle Counter (CPC). The Spider DMA was originally designed to classify 9 – 420 nm particles with 30 s scans, using 0.90 L/min sheath and 0.30 L/min aerosol flow rates. These operating parameters were considered a good trade-off between required instrument size and attainable measurement capabilities. While the instrument covers an important fraction of the complete size distribution for atmospheric particle measurements, it can only partially detect nucleation mode particles in the <10 nm range. In this work we discuss the challenges and design modifications for extending the instrument measurement range down to 4 nm, while maintaining its original physical size.

To attain mobility separation at 4 nm without changing the size of the DMA requires nearly a three-fold increase in the sheath flow rate. Yet, initial experiments at higher flowrates showed evidence of performance degradation. Finite element modeling of the flow in the Spider DMA revealed the development of flow mixing in the DMA classification region. This originated from the formation of high-velocity jets as the sheath flow passes through an array of small flow-distribution holes. No mixing was observed at the original flow conditions.

To minimize the flow effects, we considered a new design approach, wherein a “flow impingement surface” is placed immediately below the sheath flow distribution holes. We show through modeling that this relatively simple modification dampens the jet formation and eliminates the flow mixing observed in the original design. Both designs were evaluated through tandem-DMA experiments which corroborate the modeling results and validate the instrument performance.

8IM.2

Mapping the Performance of a Versatile Water-based Condensation Particle Counter (vWCPC) with COMSOL Simulation and Experimental Study. WEIXING HAO, Fan Mei, Susanne Hering, Steven Spielman, Beat Schmid, Jason Tomlinson, Yang Wang, *University of Miami*

Accurate airborne aerosol instrumentation is required to determine the spatial distribution of ambient aerosol particles, particularly when dealing with the complex vertical profiles and horizontal variations of atmospheric aerosols. A versatile water-based condensation particle counter (vWCPC) has been developed to provide aerosol concentration measurements under various environments with the advantage of reducing the health and safety concerns associated with using butanol or other chemicals as the working fluid. However, the airborne deployment of vWCPCs is relatively limited due to the lack of characterization of vWCPC performance at reduced pressures. Given the complex combinations of operating parameters in vWCPCs, modeling studies have advantages in mapping vWCPC performance.

In this work, we thoroughly investigated the performance of a laminar flow vWCPC using COMSOL Multiphysics® simulation coupled with MATLAB. We compared it against a modified commercial vWCPC (vWCPC Model 3789, TSI, Shoreview, MN, USA). Our simulation determined the performance of particle activation and droplet growth in the vWCPC growth tube, including the supersaturation, $D_{p,kel,0}$ (smallest size of particle that can be activated), $D_{p,kel,50}$ (particle size activated with 50% efficiency) profile, and final growth particle size D_d under wide operating temperatures, inlet pressures P (0.3 – 1 atm), and growth tube geometry (diameter D and initiator length L_{ini}). The effect of inlet pressure and conditioner temperature on vWCPC 3789 performance was also examined and compared with laboratory experiments. The COMSOL simulation result showed that increasing the temperature difference (ΔT) between conditioner temperature T_{con} and initiator temperature T_{ini} will reduce $D_{p,kel,0}$ and the cut-off size $D_{p,kel,50}$ of the vWCPC. In addition, lowering the temperature midpoint $T_{mid} =(T_{con} + T_{ini})/2)$ increases the supersaturation and slightly decreases the $D_{p,kel}$. The droplet size at the end of the growth tube is not significantly dependent on raising or lowering the temperature midpoint but significantly decreases at reduced inlet pressure, which indirectly alters the vWCPC empirical cut-off size. Our study shows that the current simulated growth tube geometry (D = 6.3 mm and L_{ini} = 30 mm) is an optimized choice for current vWCPC flow and temperature settings. The current simulation can more realistically represent the $D_{p,kel}$ for 7 nm vWCPC and also achieved a good agreement with the 2 nm setting. Using the new simulation approach, we provide an optimized operation setting for the 7 nm setting. This study will guide further vWCPC performance optimization for applications requiring precise particle detection and atmospheric aerosol monitoring.

8IM.3

Field Observations Using the Sulfuric Acid Dimethylamine-Reactive Condensation Particle Counter (SAD-RCPC). Dominic Casalnuovo, Darren Cheng, Christine Troller, COTY JEN, *Carnegie Mellon University*

Freshly formed particles from sulfuric acid nucleation affect the Earth’s radiative balance by forming cloud condensation nuclei (CCN). Accurately predicting global sulfuric acid nucleation rates requires high temporal and spatial resolution measurements of gaseous sulfuric acid. Accomplishing this is challenging due to the difficulties in deploying a chemical ionization mass spectrometer (CIMS) in remote regions of the atmosphere. We have developed a complementary technique to measure sulfuric acid vapor concentrations (SAD-RCPC). The SAD-RCPC consists of a compact nucleation flow reactor that uses dimethylamine to convert atmospheric sulfuric acid vapor into measurable 1-nm particles in a controlled environment. The concentration of particles is measured using a 1-nm condensation particle counter and converted to sulfuric acid concentration using a semi-empirical acid-base nucleation model. The 1-nm particles are differentiated from prexisisitng particles using pulse height analysis of the CPC output. We present operational details, laboratory validation, and field measurements of sulfuric acid vapor using the SAD-RCPC. Laboratory results demonstrate the SAD-RCPC can measure sulfuric acid vapor concentrations of 10^6 to 10^9 cm^{-3}. Field measurements of sulfuric acid vapor from Pittsburgh, PA were taken alongside a nitrate CIMS. The resulting measurements taken by SAD-RCPC identified atmospheric concentrations of sulfuric acid vapor, opening the possibility of taking sulfuric acid measurements in locations previously not reachable by CIMS.

8IM.4

A Pulsed Condensation Particle Counter for Community Monitoring. SUSANNE HERING, Gregory S. Lewis, Steven Spielman, David Pariseau, *Aerosol Dynamics Inc.*

As community monitoring of air pollutants becomes ever more widespread, it is important to develop instrumentation that can provide accurate and reliable data at a reasonable cost. Especially challenging is the monitoring of ultrafine or nanometer sized particles, as they are too small to be detected directly by optical sensors currently used for community monitoring. Reported here is a new type of condensation particle counter that targets this community measurement need. Referred to as the Pulsed Condensation Particle Counter (PCPC), this new instrument utilizes an quasi-adiabatic expansion coupled to single particle counting to monitor particle number concentrations in the 5-2000 nm size range. The PCPC introduces aerosol sample through an inlet valve into a Nafion-walled chamber surrounded by a water jacket. After a brief pause to allow for humidification, and with the inlet valve closed, a portion of the sample is extracted through an optical counter (Particles Plus LLC,. Stoughton MA). The resulting expansion creates a region of supersaturation leading to the condensational growth of the particles within the cell. The resulting droplets are individually counted as they exit the cell. The sample volume is determined from the change in pressure in the chamber during the expansion. This yields a 'first principles' measurement of ultrafine particle concentrations.

The particle size dependent detection efficiency was measured using monodispersed particles generated through electrical mobility classification with prototype for the TSI 3789 serving as reference. The PCPC detects particles as small as 5nm, with counting efficiencies above 80% for particles larger than 10nm, and above 95% for particles above 30nm. Ambient monitoring alongside a water-based condensation particle counter gives with a 5nm threshold yield regression slope above 0.9, and a correlation coefficient squared of 0.98.

This work was supported by NIEH under Grant number R44-ES031458, and through in-kind support from Particles Plus Inc.

8IM.5

Volume Measurement and Processing of Metal Nanoparticles in the Aerosol Phase. CYPRIEN JOURDAIN, Jonathan Symonds, Adam M Boies, *University of Cambridge*

Particles in the aerosol phase are largely non spherical and can exhibit complex morphologies such as agglomerates of multiple primary particles or powders with significant porosity. Determining the volume of such nanoparticles remains challenging. Volume is a crucial property as it impacts the ability of particles to conduct heat, to shape their internal electric field, and because it relates the particle true mass to its effective density. Traditionally, mass-mobility measurements are used to determine particle effective density and allow to indirectly infer the volume from a mass measurement. An alternative methodology is proposed in this work to measure the volume of nanoparticles in near real time.

The operation principle is to force electrostatic particle-droplet interaction/coagulation and to measure the changes in volume associated with the particle encapsulation. Solid particles are synthesized at high temperature (soot, metal) or dispersed (PSL, powders) and positively charged, while simultaneously, oil droplets are atomized and negatively charged. Both populations are then mobility selected and mixed in a chamber. Following the removal of charged particles, the mobility and aerodynamic diameters of the encapsulated (neutral) particles are measured, allowing the determination of the volume and the effective density.

The preliminary results show that for silver aggregates encapsulated in DEHS, linear relationships exist between the aerodynamic diameter shift and the initial mobility diameter of the silver particle (d_{mp}), given a known droplet size. The mass of the combined droplet had a 6-fold increase for the largest d_{mp} (90 nm). Aggregate volumes in the order of 10^5 nm^3 were found using a single droplet size (d_{md} = 150 nm) and aggregates with d_{mp} ranging from 30 to 90 nm. Building on these promising results, a range of particle-droplet size combinations will be tested, along with different liquid and solid materials, the latter likely to exhibit internal structures.

8IM.6

Quantifying the Three Regimes of Bipolar Charging to Improve Accuracy of SMPS Measurements. ROBERT T. NISHIDA, Tyler J. Johnson, Jason S. Olfert, *University of Alberta*

Many aerosol instruments utilize bipolar charge conditioners (neutralizers), including the widely-used scanning mobility particle sizer (SMPS). The bipolar charge distribution from a neutralizer must be known to calculate size distributions from SMPS scans. Therefore, a reliable ‘steady-state’ charge distribution is desired to improve accuracy of measurements. In this work, we show that although a ‘steady-state’ charge develops within a common Kr-85 neutralizer (TSI 3077A), gaseous ions are readily convected into tubing downstream of the neutralizer, causing significant deviation from steady-state within milliseconds. The ‘downstream ions’ are predominantly positive since negative ions are more readily lost to tubing walls due to their higher diffusivity. By example, we charge monodisperse spheres (225 nm) to an asymmetric, steady-state with mean charge per particle of -1 immediately at the neutralizer outlet. By varying downstream tubing lengths and flow rates, we show the mean charge shifts more positive in polarity to -0.4 as residence time with ‘downstream ions’ increases to ~1 s (e.g. 33 cm tube at 0.3 L/min), where it aligns with the classical charge distribution of Wiedensohler (1988). We also perform advanced numerical modelling of charging, convection and diffusion of particles and ions and show good quantitative agreement with experimental data. We thereby quantify three distinct regimes of bipolar charging, namely: the 1) charging regime (i.e. as charge develops from its initial to steady-state), 2) steady-state regime, and 3) dis-charging regime (i.e. effect of ‘downstream ions’). These three regimes of bipolar charging have wide implications for designing instrumentation, interpreting measurements and validating charging models. Finally, we present the design of a new charge conditioner which allows operation in any of the three regimes enabling new charge distributions to be achieved. The charge conditioner can be reliably operated in a steady-state regime to improve accuracy in aerosol instruments such as the SMPS.

8IM.7

Characterizing Reduced Counting Efficiencies of 23 nm Exhaust Emission Condensation Particle Counters Using Atomized Salt Particles. Helmut Krasa, Martin Kupper, Mario Anton Schriefl, ALEXANDER BERGMANN, *Graz University of Technology*

The Euro 5b legislation for light-duty vehicles introduced particle number (PN) measurements as part of the vehicle homologation process, requiring condensation particle counters (CPCs) with a counting efficiency (CE) of 0.5 ± 0.12 at 23 nm mobility diameter. While regulation R83 defines the requirements for the sampling system, it does not specify a calibration aerosol [1]. With an increasing number of countries introducing PN measurements during periodic technical inspections, a fast, cheap and compact aerosol calibration method is desired. In this work we analyzed the counting behavior of a 23 nm exhaust emission CPCs with atomized salt particles.

The CE of an AVL 23 nm CPC was evaluated using a TSI 3775 CPC (d_{50} = 4 nm) as reference instrument. In addition to commonly used NaCl, NaI, NaF and NaBr were dissolved and atomized. Furthermore, NaCl and NaBr particles were also generated in a tube furnace. The results showed that the CE is not only influenced by the particle composition, but also varies with the generation method. Compared to atomized particles, particles from the tube furnace showed increased CEs with d_{50} values of 31.7 and 38.2 nm for NaCl, respectively. The composition of the particles also had a large influence, with the NaI particles being fully counted down to 18 nm. [2]

At low dilution and high salt concentration in the atomized solution, the CE in the transition region decreased significantly for all atomized salts. Particles with electric mobility diameters of up to 150 nm were not fully counted by the 23 nm CPC, resulting in d_{50} values as large as 69.5 nm in the case of NaCl. When the dilution temperature was increased from 60 to 190 °C, the decrease in CE was mitigated and the CE was comparable to the aerosol generated in the tube furnace.

[1] Regulation No 83 of the Economic Commission for Europe of the United Nations (2015) Official Journal of the European Union. L172/1, 123-126.
[2] Krasa H, Kupper M, Schriefl M. A & Bergmann A (2023), Aerosol Sci. and Techn. 57:4, 329-341.

8SA.1

Source Apportionment, Composition and Oxidative Potential of Particulate Matter in India, China and Europe. ANDRÉ S. H. PRÉVÔT, Deepika Bhattu, Gaëlle Uzu, Yufang Hao, Peeyush Khare, Tianqu Cui, Lu Qi, Qiyuan Wang, Neeraj Rastogi, Junji Cao, Sachchida N. Tripathi, Jean-Luc Jaffrezo, Jay G. Slowik, Imad El Haddad, Kaspar R. Daellenbach, Himadri Bhowmik, Manousakas Manousos, *Paul Scherrer Institute*

The concentrations of particulate matter vary by an order of magnitude comparing the concentrations in Europe versus the ones in India and China. Also the oxidation potential of particles vary a lot between these areas. One question is if the oxidative potential (OP) as a proxy for toxicity is proportional to the mass concentration. As will be shown there is a considerable variation of oxidation potential per mass which is linked to the composition of the particles and the sources.

For Europe, we could show that secondary organic, especially anthropogenic, aerosol is a driving factor of OP in most areas of Europe with exceptions in Scandinavia where biogenic SOA is a dominant contributor and in cities vehicular wear are dominating (Daellenbach et al., 2020).

We will compare composition, sources of PM as well as the sources of oxidative potential in Europe versus different cities in China and India. Based on these results we will suggest mitigation measures in the different areas based on PM sources, but also based on OP sources.

Daellenbach, K. R., et al. (2020) Sources of particulate-matter air pollution and its oxidative potential in Europe, Nature, 587(7834), https://doi.org/10.1038/s41586-020-2902-8.

8SA.2

Local and Regional Contributions to Primary and Secondary PM2.5 in Korea. MINSU CHOI, Qi Ying, *Texas A&M University*

Air pollution is a major public health concern in South Korea, primarily caused by $PM_{2.5}$. Previous studies have suggested that PM2.5 from China accounted for a significant fraction of the total $PM_{2.5}$ in Korea. However, due to recent emission reductions in China, it is necessary to re-evaluate the contributions of local and regional sources of $PM_{2.5}$ in Korea. This study employed the Community Multiscale Air Quality (CMAQ) model with a source and age tracking framework to quantitatively analyze the contribution of domestic and international sources to $PM_{2.5}$ in Korea in 2020. The study used the Regional Emission Inventory in Asia v3.2.1 (REAS3.2.1) for anthropogenic emissions. Anthropogenic emissions from Korea were adjusted based on reported 2020 provincial emissions. To more accurately resolve the meteorological fields under complex terrain conditions and improve the prediction of $PM_{2.5}$ in Korea, nested domains with spatial resolutions down to 4 km were used. The low-spatial resolution REAS emissions were upscaled using high-resolution spatial allocation surrogates and an extensive database of the location of fossil fuel-fired power plants. The study found that while uncertainties in the heterogenous uptake of N_2O_5 and NO_2 affected nitrate concentrations near the source regions, the amount of long-range transported nitrate from China was less affected. While China still significantly influenced $PM_{2.5}$ concentrations in Korea, especially during spring, domestic sources also had a comparable contribution to the regionally transported $PM_{2.5}$ during the summer months. The study concluded that while reducing emissions in China would lead to an improvement in $PM_{2.5}$ air quality in downwind regions compared to the levels seen in the 2010s, high pollution episodes will still have a large impact on regional transport. Both domestic and international efforts are necessary to efficiently mitigate air pollution in Korea and protect public health in the future.

8SA.3

Apportioning Sources of Carbonaceous Aerosols in North Pole, Interior Alaska, with GRG Methods. SARAVANAN KANAGARATNAM, Kaitlyn McKinney, Anastasia Hewitt, Raghu Betha, Venky Shankar, *Texas Tech University*

Carbonaceous aerosols (CA) pose a significant challenge to human health and the environment. With a subarctic climate and high dependence on wood burning for heating, the City of North Pole in Interior Alaska experiences extreme levels of CA during winter. While efforts are underway to reduce wood burning, effective methods are needed to estimate the contributions of CA from various sources to monitor the effectiveness of these measures. In this study, we developed two innovative approaches to determine the source contributions of wood burning and fossil fuel combustion to Black Carbon (BC) and the contribution of BC and Brown Carbon (BrC) to total light absorption. The methods we developed – GRG-Based Variable AAE model for BC source apportionment and 2-staged Variable Component (2SVC) model for BC-BrC source contributions are based on Aethalometer (AE) measurements and do not require information on source-specific molecular markers. These methods can apportion short-term data. The results of the study showed that the contribution of biomass burning (BB%) to the BC was estimated to be 52 ± 17.8 %, and the average daily BC emitted by wood burning (BCbb) was 0.907 µg/m3 with a range of 0.02 – 4.74 µg/m3. The fractional contribution of BrC to total absorption at 370 nm was estimated to be 59.7 ± 12.4 %. The GRG-based models developed in this study performed better than the currently used models, with lower errors in the BC-BrC source apportionment. These methods provide an effective means of estimating the contributions of various sources of CA.

8SA.4

Carbonaceous Aerosols from Indonesian Peat Land Fires: Sources and Characteristics. RAGHU BETHA, Rajasekhar Balasubramanian, *Texas Tech University*

The contribution of transboundary smoke haze episodes, caused by peat and above-ground biomass fires in Indonesia, to urban airborne particulate matter (PM) in Southeast Asia (SEA) has received considerable attention from the air quality management viewpoint because of their repeated occurrence in recent years. In this study, we conducted a detailed chemical speciation and carbon isotope analysis of carbonaceous aerosols (CA) during an unprecedented smoke haze episode in Southeast Asia (SEA) in the non-ENSO year of 2013. We also present a novel source apportionment approach using a combination of latin hypercube sampling (LHS) and generalized reduced gradient (GRG) methods to estimate the individual contributions of peat and vegetative biomass to CA. Our results indicate that nearly 82% of the total carbon, as observed in Singapore, is contributed by Indonesian peat fires, with peat accounting for ~68% and vegetative biomass by ~14%. The chemical speciation of organic aerosols indicated that cellulose pyrolysis products, a form of primary organic aerosols, and the secondary dicarboxylic acids increased by a factor of 22 and 10 times, respectively. Additionally, we observed an enhancement in the concentrations of fossil fuel combustion-related compounds such as hopanes and steranes under the haze layer. The findings reveal that peatland fire activities during non-ENSO years could lead to serious haze events, affect the air quality in the SEA region significantly, and imply adverse environmental and health impacts.

8SA.5

Source Apportionment of Wintertime Organic Pollutants in a Canadian Megacity: Insights from Particle and Gas Phase Measurements.

Spiro Jorga, LAURA-HELENA RIVELLINI, Yutong Wang, Jonathan Abbatt, *University of Toronto*

Despite extensive studies on air pollution during summertime, limited research has been conducted on wintertime air pollution, where sources may differ, and the lower boundary layer and reduced oxidation levels can lead to unique atmospheric interactions. To address this knowledge gap, we conducted a study during the winter of 2023 in Toronto, a Canadian megacity, to investigate the sources and processes of particle and gaseous pollutants and their connections to each other. The temperature during that period ranged from -20^{o}C to 15^{o}C. A high-resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS) and a Proton Transfer-Reaction Mass Spectrometer (PTR-MS) were deployed, along with measurements of particle size distribution from 14 nm to 10 µm, and black carbon concentration using a PAX. The average PM_1 concentration was found to be 9 µg m^{-3} and was dominated by organics, which accounted for 70% of the mass, followed by nitrate (15%), ammonium (7%), sulfate (5%), black carbon (2%), and chloride (1%).

Positive Matrix Factorization (PMF) of the AMS and PTR-MS measurements revealed the main sources of particulate and volatile organic pollutants. We observed identifiable signals and similar time trends from mobile, cooking, and oxidation within both the gas and particles factors. The oxygenated organic aerosol (OOA) was identified as the dominant source of organic matter, accounting for 56% of the total organic aerosol, followed by cooking OA (COA) at 20%, traffic hydrocarbon-like OA (HOA) at 13%, and a combustion-like OA (combOA) at 11%. Based on correlations with particle and other gas phase measurements, the identified PMF factors from the PTR-MS measurements were: organic background (48%), mobile sources factor (20%), cooking factor (18%), a factor related to diesel vehicles (8%), and one human-connected factor (7%).

8SA.6

VCP vs. BVOC Contributions to O3 Formation during the RECAP Field Campaign in Los Angeles, CA.

Shenglun Wu, Chris Alaimo, Shang Liu, Toshihiro Kuwayama, Peter Green, Thomas Young, MICHAEL KLEEMAN, *University of California, Davis*

Ozone (O3) concentrations in Los Angeles have remained at unhealthy levels in recent years despite continued efforts to reduce precursor emissions of Volatile Organic Compounds (VOCs) and oxides of nitrogen (NOx). Significant mobile-source VOC reductions have made other residual sources (e.g., volatile chemical products (VCPs)) and biogenic VOC (BVOC) more important in urban O3 chemistry. Additional measurements are needed to identify the contribution of these VOCs to O3 formation.

Here we analyze trends in ambient NOx, O3, and VOC concentrations measured during the RECAP-CA field campaign in Redlands, CA between July and October, 2021. Atmospheric VOC samples were collected from 10AM to 12PM using Markes Universal Thermal Desorption (TD) tubes and 2,4-dinitrophenylhydrazine (DNPH) tubes. VOCs were measured in the lab by GC-MS and LC-MS following a rigorous protocol of multi-point calibrations using authentic standards. A total of 95 VOC species were found above detection limits including hydrocarbons, halogenated and oxygenated VOCs, and siloxanes.

Positive Matrix Factorization (PMF) applied to the VOC measurements identified nine VOC sources including traffic-related, biogenics, VCPs (Siloxane), plant decomposition, ethanol derived from VCPs, commercial and industrial solvents, and two local institutions related sources. O3 formation associated with PMF sources was estimated through a VOC-reactivity-based method and a method based on photochemical box model. The reactivity-based method uses Ozone Formation Potential (OFP) to calculate the fraction of the O3 formation associated with each PMF source. The box-model-based method utilized an O3 source apportionment calculation carried out under observed atmospheric conditions. The two O3 apportionment methods predicted similar VOC source contributions to O3 formation, building confidence in the results. BVOCs (~25%) made the largest contribution to O3 formation. VCPs made a lower contribution (~20%) than BVOC, and traffic-related VOCs made an even lower contribution (~15%). Implications for emissions control strategies will be discussed.

8SA.7

Influence of Intermediate and Semivolatile Organic Compound Emissions from Cooking-Related Sources on Urban Air Quality. JO MACHESKY, Mia Tran, Minguk Seo, Taekyu Joo, Tori Hass-Mitchell, Mitchell Rogers, Benjamin A. Nault, Joseph Roscioli, Manjula Canagaratna, Jordan Krechmer, Albert Presto, Andrew Lambe, Drew Gentner, *Yale University*

Cooking emissions, including those from commercial kitchens, are a known source of atmospheric primary organic aerosol. However, gas-phase cooking emissions are poorly constrained and include a range of volatile, intermediate-volatility, and semivolatile organic compounds, including relatively high contributions of functionalized species, such as nitrogen and sulfur-containing organic compounds, whose atmospheric fates are also uncertain. Emissions of condensed IVOCs-SVOCs can evaporate into the gas-phase following emission and serve as precursors to secondary organic aerosol formation following photochemical oxidation. Leveraging existing cooking tracers and profiles provides a priori source apportionment constraints while also allowing for other less-studied gas-phase cooking-related compounds to be identified through statistical analysis of covariance with known source factors. Here, we investigated measurements of tracers for cooking emissions from two recent field campaigns, the summer 2022 NYC-METS campaign in Manhattan (NY), a part of the broader AEROMMA effort, and the summer 2019 SEARCH-CACES mobile laboratory near-source measurements.

In Manhattan, proton-transfer-reaction mass spectrometry and iodide chemical ionization mass spectrometry were used for high temporal resolution analysis of known cooking tracers and evaluated for covariance with COA enhancements determined from aerosol chemical speciation monitor measurements. These online observations, combined with offline speciated measurements of functionalized compounds via high-resolution time-of-flight mass spectrometry with gas chromatography, enable a top-down analysis of cooking emissions focusing on expanding source profiles to include greater representation of functionalized gas-phase organic compounds. Near-source cooking plume samples collected on gas-phase adsorbent tubes during the 2019 SEARCH-CACES mobile laboratory campaign further this effort with highly concentrated restaurant plume samples that expand real-world measurements of functionalized compounds. Together with emissions profiles of known gas-phase cooking tracers and source profiles from previous studies, our results will enable a broader understanding of complex mixtures of gas-phase organic compounds emitted from cooking and a more detailed modeling of their impact on urban organic aerosols.

8SC.1

Advancements in Networkable and Low-Cost Monitoring at AethLabs: an Exposition of a New WiFi-Enabled Portable microAethalometer, a Networkable Multi-Pollutant Aerosol and Gas Monitor, and an MA-series Firmware Upgrade to Add WiFi and Source Apportionment. JEFF BLAIR, Steven Blair, Tanja Dobovicnik, Ivan Iskra, L. Drew Hill, *Aethlabs*

$PM_{2.5}$ and its black carbon (BC) component have been well-characterized in their abilities to induce respiratory and cardiovascular responses at low exposure concentrations. Actual ambient concentrations to which individuals are exposed depend heavily on local emissions sources. For aerosols < 2.5 µm in diameter, such concentrations have been shown to vary in health-relevant amounts on a geospatial scale as small as city block to city block. Temporally, $PM_{2.5}$ and BC concentrations can jump by orders of magnitude in a minute or less. It is critical that commercially available monitors reflect these needs. We present a new set of AethLabs devices that will help researchers, communities, and government agencies capture BC, $PM_{2.5}$, and gas data at more actionable spatial resolutions in real-time and a software update that adds wireless data telemetry and source apportionment features to existing AethLabs MA-series aethalometers. AethLabs' new devices include the AethLabs microAeth® AL30 – a low-cost pocket-sized personal black carbon monitor with built-in WiFi networking and remote data and device management, a 24 hour internal battery, sensors for assessing sample temperature, relative humidity, pressure, and accelerometry, and a 1-hour lower limit of detection preliminarily assessed at 0.003 $\mu g/m^3$ (averaged from 5-min timebase data, 250 mL/min flow) – and the AethLabs "Scout" – a small networkable (WiFi) monitor with multiple sensing capabilities including optical $PM_{2.5}$ & $PM_{1.0}$ with sample conditioning to reduce hygroscopic effects, photoacoustic CO_2, metal oxide total VOC, temperature, relative humidity, and barometric pressure. Source apportionment in existing MA-series instruments is based on the peer-reviewed Aethalometer Model to estimate BC concentrations produced by biomass combustion and, comparatively, BC concentrations produced by fossil fuel combustion. Examples will be presented.

8SC.2

A Novel Approach for Determination of Carbonaceous Aerosols by Using Aerosol Magee Scientific Carbonaceous Aerosol Speciation System (CASS) and Software Carbonaceous Aerosol Analysis Tool (CAAT). KLEMEN KUNSTELJ, Matic Ivančič, Asta Gregorič, Gašper Lavrič, Bálint Alföldy, Irena Ježek, Martin Rigler, *Aerosol d.o.o.*

Carbonaceous aerosols (CA) are usually the most significant contributor to fine particulate matter (PM2.5) impacting climate change and public health. CA include an organic fraction, organic aerosol (OA), and a refractory, strongly light-absorbing fraction referred to as black carbon (BC). The mass of carbon atoms in CA and OA is called total carbon (TC) and organic carbon (OC), respectively. The BC is exclusively emitted from incomplete combustion (fossil fuel BCff, biomass burning BCbb), thus having only a primary origin. OA's chemical composition is highly diverse and composed of many complex molecular structures. OA is directly emitted to the atmosphere in particulate form as primary organic aerosols (POA) by combustion and from biogenic sources, or it can have a secondary origin (SOA).

The combination of Total Carbon Analyzer TCA08 and the Aethalometer® model AE33 (known as CASS) provides a novel approach for measuring different components of carbonaceous aerosols in near-real-time with high-time resolution.

The CAAT abbreviation stands for Carbonaceous Aerosol Analysis Tool and is a software tool for analyzing data from the AE33, the TCA08, and CASS instrument. Its main progression tasks are as follows: Import, Validation and Analysis procedures, such as diurnal profiles, Time averages, Absorption coefficient, Angstrom exponent, Attenuation, Source Apportionment, concentration determination of some most relevant carbonaceous aerosol species (Total Carbon, Elemental Carbon, Organic Carbon, Black and Brown Carbon).

With this work, we want to show capabilities of the newly developed instrument CASS and the Analytical software to indicate and forecast particular trends and seasonal variations of concentrations of the specific carbonaceous aerosols.

9AC.1

Photooxidative Fate of Atmospheric Methylated Selenium Compounds. ERIN BOWEY, Yumeng Cui, Roya Bahreini, Kunpeng Chen, Linhui Tian, Michael Lum, Ying-Hsuan Lin, Don Collins, *University of California, Riverside*

Atmospheric oxidation of methylated selenium compounds can lead to formation of secondary organic aerosols (SOAs). The nature and degree of the toxic effects of Se-containing organic compounds in the environment and on human health depend largely on their oxidation state and gas-particle partitioning potential. To explore this, photooxidation experiments of dimethyl selenide (DMSe) and dimethyl diselenide (DMDSe) precursors under low NOx conditions were carried out in an environmental chamber. An aerosol mass spectrometer (mAMS), a Scanning Electrical Mobility Spectrometer (SEMS), and a chemical ionization mass spectrometer (I- ToF-CIMS) were used to investigate online aerosol composition, size distribution, and gas phase concentration of the formed products. A denuder and filter pack system was also used to collect gaseous and particulate samples both before and after the peak in SOA mass concentration was reached for offline analysis of carbonyls. This allows the evolution of the products' oxidation state and partitioning behavior over time to be followed. The denuders and filters were coated with the derivatizing agent, O-(2,3,4,5,6-pentafluorobenzyl)hydroxylamine (PFBHA) which converts the carbonyl species into their oxime derivatives for immediate extraction post-sampling and analysis with GC-MS. It is expected that higher carbon oxidation states will be observed after peak mass loading is reached than before, and that the gas phase samples will be dominated by small carbonyls while the particle phase will contain large carbonyls containing Se in their backbone. Lastly, PTFE filter samples were collected near the end of each experiment to obtain molecular information of the formed SOAs by offline analysis on FIGAERO-ToF-CIMS (I-). Results from these various measurements will be synthesized to improve our understanding of atmospheric chemistry of methylated Se species under low NOx conditions.

9AC.2

Oxidative Potential and ROS Speciation in Organoselenium Derived Secondary Organic Aerosols. MICHAEL LUM, Erin Bowey, Linhui Tian, Kunpeng Chen, Ningjin Xu, Ying Zhou, Alexa Canchola, Wonsik Woo, Don Collins, Roya Bahreini, Ying-Hsuan Lin, *University of California, Riverside*

Trace levels of selenium (Se) are widespread and ubiquitous in the environment due to long-range transport processes through the atmosphere as alkylated organoselenium compounds or elemental Se produced from combustion. Dimethyl selenide (DMSe) and dimethyl diselenide (DMDSe) are organoselenium compounds that produce secondary organic aerosols (SOA) through atmospheric oxidation. Prior laboratory experiments showed that Se-enriched SOA formed from the DMSe precursor had a higher oxidative potential than ambient urban aerosols. The resulting SOA contained a mixture of chemically reactive compounds, however, the presence and identities of radicals acting as reactive oxygen species (ROS) produced during this process have yet to be detailed. For this study, DMSe- and DMDSe-derived SOA samples from atmospheric oxidation under varying environmental conditions were collected and analyzed to determine their aerosol oxidative potential using the dithiothreitol (DTT) assay, as well as determine the identities and concentration of radical ROS using electron paramagnetic resonance (EPR) spectroscopy. The proportions of each radical species (e.g., hydroxyl radicals, superoxide or hydroperoxide radicals, alkyl radicals, and alkoxy radicals) normalized to the total radical concentration of each sample will be discussed. Though Se-rich aerosol has been shown to have higher oxidation potential, the results of this study will contribute to an improved understanding of the relative abundance and speciation of these ROS, which will have a large impact on possible secondary particle phase chemical reactions, major product identities, and oxidative stress in humans upon exposure.

9AC.3

Secondary Organic Aerosol Formation from OH-Initiated Oxidation of o-cresol. Cecilie Carstens, David Bell, FÉLIX SARI DORÉ, Jens Top, Clément Dubois, Yanjun Zhang, Sebastien Perrier, Imad El Haddad, Matthieu Riva, *CNRS-IRCELYON*

Secondary organic aerosols (SOA) have significant effects on visibility, human health, and climate. They are formed in the atmosphere from the oxidation of volatile organic compounds (VOCs), leading to less volatile oxidation products that can subsequently partition into, or react with existing, aerosol particles. Biomass burning (BB) is the largest combustion-related source of VOCs in the atmosphere, and extreme fires has been estimated by United Nations Environment program to increase with up to 30% by 2050, which underlines the necessity to study how BB affects the SOA formation.

Recent studies have shown that oxygenated aromatic compounds account for almost 60% of the SOA formed under dry conditions from BB emissions. In this study we used an oxygenated aromatic BB marker, i.e., o-cresol (C_7H_8O), to study the chemical processes leading to the formation of biomass-derived SOA. Experiments were performed in a 9m^3 Teflon atmospheric simulation chamber at the Paul Scherrer Institute. Numerous mass spectrometers were used to investigate gas- and particle-phase oxidation processes under wet and dry conditions.

Preliminary results show that OH-initiated oxidation of o-cresol leads to the subsequent formation of SOA under wet and dry conditions. Notably, humidity greatly influences the distribution of particle-phase products, especially for nitrogen-containing compounds (ONs). Particulate ONs are formed to a greater extent under wet conditions. This can potentially influence the recycling of nitrogen oxides (NO_x) and change the NO_x budget on a global scale with the increase of BB from e.g., wildfires.

9AC.4

Gas-Phase Oxidation Products and SOA Yields from a-Pinene Oxidation under a Range of RO2 Reaction Conditions. LESLY FRANCO DELOYA, Erik Helstrom, Hannah Kenagy, Yaowei Li, Frank Keutsch, Jesse Kroll, *MIT*

Peroxy radicals (RO_2) are key intermediates in the oxidation of volatile organic compounds (VOCs) and the formation of secondary organic aerosol (SOA). RO_2 radicals can undergo a number of reactions, including reaction with hydroperoxy radicals (HO_x), reaction with nitric oxide (NO), or isomerization; given that each of these channels forms different products, this branching likely impacts the production of SOA. However, previous laboratory studies have typically examined SOA yields under either very high or very low concentrations of NO and have not systematically examined SOA yields at the full atmospheric range of RO_2 fates. In the present study, we examine gas-phase products and SOA yields under a wide range of RO_2 reaction conditions. We oxidized α-pinene in a 7.5 m^3 environmental chamber and used varying concentrations of hydroxyl radical (OH) precursors, nitrous acid (HONO) and hydrogen peroxide (H_2O_2), to vary the relative branching among different RO_2 channels. A chemical ionization mass spectrometer (CIMS) was run in both water and ammonium mode to sample a wide range of gas-phase oxidation products and an aerosol mass spectrometer (AMS), Thermal Denuder-Aerosol Mass Spectrometer (TD-AMS), and scanning mobility particle sizer (SMPS) were used to collect particle-phase information. We identify gas-phase α-pinene organic oxidation products that serve as markers for different RO_2 channels; these provide experimental constraints on the RO_2 chemistry occurring in the chamber (e.g., RO_2+NO, RO_2+HO_2, RO_2 isomerization). This enables us to describe SOA yields as a function of RO_2 reaction conditions, which can be used to improve SOA parameterizations within chemical transport models.

9AC.5

Multi-Generational Autoxidation Chemistry in the α-Pinene+Oh System and Dual Roles for NO in SOA Formation.

MASAYUKI TAKEUCHI, Jean Rivera-Rios, Nga Lee Ng, Ivan Piletic, Emma D'Ambro, Joel A. Thornton, Benjamin Murphy, Havala Pye, *Georgia Institute of Technology*

Evidence for autoxidation, rapid gas-phase oxidation of organic vapors, has recently emerged, though its implication for the formation of secondary organic aerosol (SOA) in varying environmental conditions (e.g., NO level) is not well understood. The presence of a high NO level suppresses first-generation autoxidation reactions by shortening the lifetime of peroxy radicals (RO_2). However, for cyclic precursors, a high NO level also promotes further ring-opening processes of first-generation products via alkoxy radical decomposition followed by RO_2+NO. The higher-generation RO_2 can potentially undergo similar or faster autoxidation than first-generation RO_2 due to increased conformational flexibility, though studies on autoxidation of higher-generation RO_2 are limited. Moreover, higher-generation RO_2 are likely more functionalized and contain more labile sites to abstract H atoms to propagate autoxidation. In this study, we expanded an explicit α-pinene+OH mechanistic model by including multi-generational autoxidation chemistry. SOA formation and properties from the model results were compared with our chamber experiment data to evaluate the model responses and to understand the dual roles of NO in autoxidation processes. For ambient relevant levels of NO (0.01−10 ppb) and HO_2 (1−100 ppt) in a monoterpene-rich environment (i.e., southeastern U.S.), our model revealed that the majority of SOA is of low volatility ($\log_{10}(C^*$, μg m^{-3}) <0) rather than semi-volatile and that SOA formation potential (mass yield) from α-pinene+OH oxidation is very similar among urban (Atlanta, GA) and rural sites (Centreville, AL), consistent with prior ambient measurements. This occurs because the competing effects of NO in suppressing α-pinene RO_2 autoxidation and facilitating multi-generational autoxidation offset each other for the range of NO level tested. Since ambient NO_x emissions also contribute to atmospheric oxidative capacity, future reductions of NO_x are likely to lead to benefits of decreasing PM level via reduced SOA from α-pinene+OH oxidation.

9AC.6

Impact of Acidic Aerosol on Deceleration of SOA Formation from the Photooxidation of Phenol or Benzene.

Jiwon Choi, MYOSEON JANG, *University of Florida*

Understanding phenol's oxidation mechanisms is essential to accurately predict a secondary organic aerosols (SOA) formation from the atmospheric process of benzene. The atmospheric oxidation of phenol produces a considerable amount of a Persistent Phenoxy Radical (PPR), which can catalytically consume ozone via a NO_x cycle. This PPR can negatively influence SOA formation due to the reduction of OH radicals and hydrocarbon consumption. Unexpectedly, we discovered that phenol SOA growth was considerably retarded by acidic seed. It hypothesizes that the formation of PPR from phenol oxidation is accelerated via a heterogeneous acid-catalyzed reaction of phenols in acidic seed, and also retards SOA formation. In this study, the explicit gas mechanisms of phenol were developed as a function of aerosol acidity to simulate the suppressed phenol oxidation and improve benzene oxidation mechanisms. Then, resulting gas products were incorporated into the UNIfied Partitioning Aerosol Reaction (UNIPAR) model to predict SOA formation via multiphase reactions of hydrocarbons. Gas products were lumped based on volatility-reactivity characteristics and involved in their multiphase partitioning and aerosol phase oligomerization. The suitability of gas mechanisms and SOA model was examined by simulating data obtained in the UF-APHOR chamber under different conditions (NO_x levels, humidity, and aerosol acidity) with ambient sunlight. Both chamber data and model simulation show that with sulfuric acid seed, ozone formation, the consumption of phenol and benzene, and SOA growth were significantly suppressed, compared to those without inorganic seed. The impact of aerosol acidity on phenol SOA mass is invisible due to the net effect, the acceleration of acid-catalyzed oligomerization of reactive products and the deceleration of product aging by PPR. In benzene oxidation, about 53% oxidation pathway are connected to phenol formation in the current gas mechanism. Hence, benzene is more impacted by acid-catalyzed oligomerization than phenol showing the increased SOA mass with acidic seed.

9AC.8

Revealing the Chemical Processes Governing the Evolution of Particle Oxidation Products from Naphthalene OH Initiated Oxidation. FÉLIX SARI DORÉ, Yanjun Zhang, Cecilie Carstens, Jens Top, Clément Dubois, Sebastien Perrier, Imad El Haddad, David Bell, Matthieu Riva, *CNRS-IRCELYON*

Secondary organic aerosols (SOAs) are known to substantially influence the climate by absorbing or scattering solar radiation or promoting cloud formation. The uncertainties regarding the formation of SOAs make their contribution to the Earth's radiative forcing difficult to quantify. SOAs can be formed from the oxidation of either primary organic aerosols (POAs) or volatile organic compounds (VOCs). In this study, the oxidation of one of the most important anthropogenic VOC, naphthalene, has been studied in a 9m3 Teflon chamber to better understand the chemical mechanisms occurring in the atmosphere. Naphthalene was mixed with tetramethylethylene (TME) and O3, resulting in hydroxyl radicals' oxidation of the VOC, both with and without UV lights. The OH-initiated oxidation of naphthalene resulted in monomers and dimers in dark conditions in both particle and gas phases. Particle-phase chemistry and gas-phase chemistry were studied using an extractive electrospray ionization time-of-flight (EESI-ToF) mass spectrometer and a chemical ionization orbitrap (CI-Orbitrap) mass spectrometer respectively. Under UV lights, a decrease in the production of dimers with 20 carbon atoms was observed. Meanwhile, an increase in the production of dimers exhibiting a shorter carbon skeleton occurred, indicating that photolysis of the C20 compounds yields the fragmentation of dimeric compounds. These observations were also observed in a similar experiment in which naphthalene reacted with OH radicals produced from HONO photolysis, which resulted in both nitrogen (N-) and non-nitrogen-containing species. As the experiment went on, the production of non-N-containing monomers decreased as the production of non-N-containing dimers increased, as in the first experiment. A similar trend was also observed between N-containing monomers and N-containing dimers, the former presumably undergoing oligomerization to form the latter. This study explores the chemical processes occurring within particle-phase that could help better understand the evolution of the oxidation products within atmospheric aerosol particles.

9AC.9

Products of Alkoxy Radical Reactions in the Atmospheric Aqueous Phase: Impact of Chemical Structure on Product Distributions. LEXY LEMAR, Victoria Barber, Yaowei Li, Frank Keutsch, Jesse Kroll, *MIT*

The atmospheric oxidation of organic species, which leads to the formation of secondary organic aerosol (SOA) and other pollutants, can occur both in the gas phase and in the condensed phase. Oxidation typically occurs via key radical intermediates (R, RO, and RO_2), and the reactions of these are not well known in the atmospheric aqueous phase (i.e., deliquesced aerosol particles). Reactions that are too slow in the gas phase due to low concentrations could be important in the aqueous phase. In this study, we investigate how the reaction pathways of alkoxy (RO) radicals in bulk aqueous solution differ from those in the gas phase and how these differences depend on the carbon skeleton. Single isomer RO radicals are generated photolytically from alkyl-nitrite precursors in both an environmental chamber (gas phase) and in solution (aqueous phase). Single-isomer radical generation simplifies the subsequent chemistry and provides clear linkage between specific radicals and oxidation end products. For aqueous phase experiments, the reaction mixture is fed into an atomizer and injected directly into an ammonium chemical ionization mass spectrometer (CIMS). This provides the concentrations and molecular formulas of organic products, yielding insight into the mechanisms and branching ratios in the aqueous solution. The same instrument is used to determine products in the gas phase experiments for direct comparison. For pathways that became more dominant in the aqueous phase, an enhancement factor was calculated to compare across different species. Initial data demonstrate that the phase-dependent differences in downstream chemistry are highly dependent on the carbon skeleton of the organic radical. For example, the enhancement factor for the 1,5-H shift isomerization changes with degree of substitution. Results from this study provide insight into not only the aqueous phase chemistry of alkoxy radicals and insight to the competition between the various pathways as a function of phase.

9AC.10

Evolution of Secondary Organic Aerosol Composition during Photochemical Ageing. OLGA GARMASH, Ben H. Lee, Maria Zawadowicz, John Shilling, Joel A. Thornton, *University of Washington*

Aerosol particles in the atmosphere affect climate and human health. One of the most abundant constituents of atmospheric particles is secondary organic aerosol (SOA), which forms through oxidation and condensation of organic compounds. In the condensed phase, these compounds undergo additional reactions upon exposure to sunlight and oxidants, otherwise known as ageing. These reactions, in turn, affect the physio-chemical properties of the aerosols, such as hygroscopicity and volatility, and alter their role in the atmosphere.

In the current study, we investigated the ageing of SOA particles produced from the commonly emitted organic compounds from biogenic sources (isoprene, α-pinene and β-caryophyllene) and anthropogenic sources (trimethylbenzene). The experiments were conducted at the Pacific Northwest National Laboratory atmospheric chamber operated in a batch mode. The SOA particles were formed in oxidation by OH-radical and subsequently aged over 15-30 hours under simulated sunlight. SOA composition was routinely sampled using FIGAERO inlet coupled to iodide-ion chemical ionization mass spectrometer. In this presentation, I will discuss the detailed evolution of chemical components undergoing rapid oligomerization and fragmentation as well as the production of lower-volatility species as the ageing progresses. The results of this work will help us to improve our ability to predict the lifetime and cloud-forming potential of organic aerosol particles in the atmosphere.

9AC.11

Secondary Organic Aerosol Formation from Glycol Ethers. REINA BUENCONSEJO, Haroula D. Baliaka, Paul Wennberg, John Seinfeld, *California Institute of Technology*

Recent work indicates the growing importance of volatile chemical products (VCPs), particularly as air pollution regulations drive down the contribution of vehicular-based emissions. It is important to characterize the effects of VCPs on atmospheric secondary organic aerosol (SOA) and its formation to better resolve discrepancies between SOA observations and models. This work looks at ethoxyethanol and butoxyethanol, VCPs used as industrial solvents, cleaning supplies, and paints.

Using a 19 m^3 environmental smog chamber, SOA yields of glycol ethers, including ethoxyethanol and butoxyethanol, are probed over a range of NO mixing ratios and RO_2 bimolecular lifetimes to better understand SOA formation as a function of a variety of different environmental conditions. Gas-phase chemistry leading up to SOA formation is analyzed using a CF_3O^- chemical ionization mass spectrometer (CIMS).

In low-NOx conditions, the unimolecular hydrogen shift reaction to the ethoxyethanol peroxy radicals is shown to be important, making this autoxidation competitive with bimolecular pathways. This work addresses glycol ethers as a chemical class of VCPs. In particular, this work is relevant to urban environments like the Los Angeles Basin where NO_x levels and other vehicular emissions continue to decrease but where VCPs are continuing to play an important role in air quality.

9AC.12

The Role of Particle-Phase Criegee Intermediates in the Ozonolysis of Organic Aerosol.

RYAN REYNOLDS, Kevin R. Wilson, *Lawrence Berkeley National Laboratory*

Criegee intermediates (CI) are central to the ozonolysis of unsaturated organic compounds, controlling the formation of both lighter-molecular weight fragmentation reaction products and heavier oligomers through competing unimolecular and bimolecular pathways. In particular, the reaction of thermalized CI with carboxylic acids (RCOOH) to produce oligomeric α-acyloxyalkyl hydroperoxides (AAHPs) is of interest in the chemical transformation of organic compounds in the atmosphere. We investigate this reactive sink of CI in the particle phase under different atmospherically-relevant conditions using aerosol flow tube experiments to study the ozonolysis of model submicron organic aerosol containing an n-alkene (Z-9-tricosene) and different reaction partners, including a saturated RCOOH. Recent experimental results at room temperature have indicated that the CI + RCOOH reaction in the particle phase proceeds much slower than expected given analogous gas-phase measurements, approximately six orders of magnitude slower than the expected diffusion limit in a liquid organic matrix. Companion kinetic modeling efforts suggest that the bimolecular CI + RCOOH reaction is competitive with unimolecular decay of the CI in the particle phase. Further studies of CI + RCOOH and related reactions reveal the impact of multiple factors on the reaction kinetics of this model system, such as temperature dependence and competing heterogeneous processes.

9AC.13

SOA Formation from the Ozonolysis of Various Sesquiterpenes and the Photooxidation of Their First Generation Products.

CHRISTINA N. VASILAKOPOULOU, Agata Kołodziejczyk, Kalliopi Florou, Christos Kaltsonoudis, Angeliki Matrali, Damianos Pavlidis, Spyros N. Pandis, *University of Patras, Greece*

The oxidation of biogenic volatile organic compounds is an important pathway of the formation of secondary organic aerosol (SOA). The SOA formation by isoprene and the monoterpenes has been studied extensively, however less is known about the role of sesquiterpenes. Laboratory chamber experiments were conducted in order to study the SOA formation from the ozonolysis of various sesquiterpenes (b-caryophyllene, a-humulene, d-cadinene) as well as from the reactions of three of their products (b-nocaryophyllinic acid, 2-(2-carboxyethyl)-3,3-dimethylcyclobutanecarboxylic acid and 2-(2-methyl-6-oxoheptan-3-yl)-3,6-dioxoheptanal) with the OH radical. These products were synthesized for the purposes of this study. The investigation of their oxidation allows the quantification of the role of later generation reactions in the system and the potential additional SOA formation.

The particle phase was continuously characterized using an aerosol mass spectrometer (AMS), the CHARON/PTR-MS and a scanning mobility particle sizer (SMPS). A high resolution PTR-MS and standard gas monitors were used for the measurements of the various compounds in the gas phase. Samples were also collected at the end of each experiment, which were analyzed with LC-MS.

Our results indicate that the produced SOA from sesquiterpenes can eventually become quite oxidized having O:C around 0.7. Previous experimental work has suggested that the final O:C of sesquiterpene SOA is much lower. Also, a number of the first generation products continue reacting and the SOA mass spectrum evolves rapidly. The AMS spectrum changed by 20-25 degrees as the fresh SOA was aging. This suggests that identification of the corresponding SOA under ambient conditions based on the first generation products may be problematic. The composition of the fresh and the aged SOA and the implications for the quantification of the sesquiterpene SOA in the field will be discussed.

9AC.14

Aqueous Phase Photochemical Transformations of Phenolic SOA: Effects of Organic Concentration and Ionic Strength on SOA Chemistry. CHRISTOPHER NIEDEK, Wenqing Jiang, Yuejun Zhou, Lan Ma, Cort Anastasio, Qi Zhang, *University of California, Davis*

Understanding the formation mechanisms and properties of secondary organic aerosols (SOA) in atmospheric aqueous phases is critical for predicting and mitigating air pollution on a regional scale as well as global climate change. Biomass burning can generate significant amounts of phenolic species and previous studies have demonstrated their potentially large contribution to SOA mass via aqueous phase transformations. However, most of the studies have been performed under relatively dilute, cloud/fog water conditions. Concentrations of organics as well as ionic strength can vary greatly from cloud/fog waters to aerosol liquid water (ALW) conditions. The effects of differing concentrations of phenolics, photosensitizers, and ionic strength on SOA formation remains understudied.

This work is focused on characterizing aqueous phase SOA (aqSOA) formed from triplet excited states of organic compounds (3C*) oxidation of guaiacyl acetone (GA) under varying initial organic concentrations and ionic strengths using a short-pathlength photoreactor and a high-resolution aerosol mass spectrometer (HR-AMS). Our new photoreactor design allows for a variable light pathlength which makes exploring ALW-type conditions, where high concentrations of absorbing species can make light absorption a practical concern, more accessible. Previous work has shown that high ionic strength conditions have little effect on GA decay rates, but changes to aqSOA chemistry and kinetics were not previously explored. The mass yields, bulk composition, and photochemical evolution of the aqSOA were studied under a range of initial [GA], [3C*], and ionic strengths. High ionic strength conditions have little effect on the GA decay rate, but it can increase the formation rates of key aqSOA tracers like oligomers. This work suggests that ionic strengths typically found in ALW can modify formation rates of key brown carbon species (e.g. phenolic oligomers), suggesting the influence of phenols on the radiative properties of clouds indicated by previous studies may be greater in particles and ALW.

9AC.16

Formation Kinetics of Isoprene Epoxydiol-Derived Secondary Organic Aerosol Are Altered Near the Sulfate/Bisulfate pKa. N. CAZIMIR ARMSTRONG, Madeline Cooke, Yuzhi Chen, Molly Frauenheim, Zhenfa Zhang, Avram Gold, Andrew Ault, Jason Surratt, *University of North Carolina at Chapel Hill*

Low-pH aerosols comprise a large fraction of atmospheric fine particulate matter. The effects of pH on secondary organic aerosol (SOA) formation are not well understood, in part because of the difficulty of accurately measuring aerosol pH. Of particular interest are the atmospherically-abundant isoprene epoxydiols (IEPOX), which undergo acid-driven reactions to form SOA. Models have assumed no upper limit for IEPOX-SOA formation rates as acidity increases. However, recent work has shown that organosulfate formation from IEPOX slows as the equilibrium of inorganic sulfate ($\text{Sulf}_{\text{inorg}}$) shifts from sulfate ($SO_4^{2-}$) towards bisulfate ($HSO_4^-$), which is a weaker nucleophile. We performed a series of trans-ß-IEPOX uptake experiments with ammonium sulfate seed solutions acidified to between pH 0 and 3, and modelled time-resolved methyltetrol (MT) and methyltetrol sulfate (MTS) formation and $\text{Sulf}_{\text{inorg}}$ consumption ($k_{MT} = 0.018\ M^{-2}\ s^{-1}$, $k_{MTS} = 0.28\ M^{-2}\ s^{-1}$). We found an inflection point between pH 1 and 1.4, below which MT formation dominates and above which MTS formation dominates, consistent with a changing balance of protonated and deprotonated $\text{Sulf}_{\text{inorg}}$. Modelled MT and MTS formation fit the experimental data well both above and below the inflection point except at pH 1.4, where it significantly underpredicted the data at low initial IEPOX/$\text{Sulf}_{\text{inorg}}$ ratios. This indicates multi-phase chemical dynamics beyond those represented in our model, leading to very efficient IEPOX-SOA formation at pH 1.4. Further investigation is warranted into the connection of IEPOX-SOA formation with initial IEPOX/$\text{Sulf}_{\text{inorg}}$ ratio and aerosol pH.

9AC.17

Amore 2.0: A New and Improved Algorithm for the Reduction of Atmospheric Oxidation Mechanisms. FORWOOD WISER, V. Faye McNeill, Siddhartha Sen, Daniel Westervelt, Benjamin Yang, Arlene Fiore, Daven Henze, Arijit Chakraborty, *Columbia University*

Atmospheric chemical models are limited in size due to the computational constraints of atmospheric simulations. However, through experimental and computational methods, a large number of high fidelity large mechanisms have been developed for the oxidation of atmospheric organics. These mechanisms often have limited application in atmospheric simulations due to their size. To address this problem, we have developed a set of algorithms for the reduction of atmospheric oxidation mechanisms. Our first algorithm, AMORE 1.0 was used to create a highly accurate reduced isoprene oxidation mechanism with 12 species from a starting point of 404 species. This approach required manual input to finalize the mechanism, and was only able to create very small mechanisms. Here we present AMORE 2.0, a new and improved algorithm for the high fidelity reduction of atmospheric oxidation mechanisms. The AMORE 2.0 algorithm is rooted in graph theory, and produces accurate mechanisms that are far smaller than the input full mechanisms. In contrast to the AMORE 1.0 algorithm, which selected optimal reduced pathways for the reduced mechanism, the AMORE 2.0 algorithm ranks species in order of their importance to the mechanism, and removes them in that order. Unlike other methodologies, the reactions involving removed species are rerouted so that species removal has minimal impact on other parts of the mechanism. This algorithm requires no manual adjustments, and reduces mechanisms in a stepwise fashion, allowing users to select the desired mechanism size, with increased accuracy for larger mechanisms. In addition, as a rules-based algorithm, the results are highly interpretable. Examples are given for the isoprene, furans, and alpha pinene mechanisms.

9AC.18

Classification of Novel Chemical Markers in Secondary Organic Aerosol Formation through Incorporation of Laboratory and Ambient “Unknown” Species into an Open-Access Mass Spectral Database (UCB-GLOBES). LINDSAY YEE, Emily Franklin, Robert Weber, Taekyu Joo, Masayuki Takeuchi, Gamze Eris, Weiqi Xu, Nga Lee Ng, Yuzhi Chen, John Shilling, Allen Goldstein, *University of California, Berkeley*

Ambient organic aerosols contain hundreds to thousands of unique compounds, yet positive chemical identification is typically limited since most atmospheric compounds are uniquely created in the atmosphere and few authentic standards exist. This results in analyses focused on tracking a fewer number of well-known chemical markers for specific pathways to secondary organic aerosol (SOA) formation. To better understand the atmospheric importance of “unknowns,” we have analyzed laboratory and field samples of organic aerosols on quartz filters representing a variety of sample types and chemical regimes (e.g. biomass burning, isoprene and terpene oxidation, natural, rural, and urban environments) using two-dimensional gas chromatography with high-resolution time-of-flight mass spectrometry. In total, we have extended the open-access electron impact mass spectral database known as the University of California, Berkeley, Goldstein Library of Organic Biogenic and Environmental Spectra (UCB-GLOBES) to include ~25,000 mass spectra. By contrasting the chemical composition of species observed in laboratory oxidation experiments with known precursors and those observed in field samples (e.g. Southeast U.S. and Central Amazon), we investigate which unknown species can serve as new chemical markers for specific SOA pathways and further classify these markers by predicted chemical properties (e.g. average carbon oxidation state, carbon number, vapor pressure).

9AC.19

Comparison of Common Vapor Pressure Estimation Methods and the Effect of Viscosity on SOA Formation through Modeling of Alkene OH/NOx Systems. EMMALINE LONGNECKER, Julia Bakker-Arkema, Zhe Peng, Paul Ziemann, *University of Colorado Boulder*

Modeling of secondary organic aerosol (SOA) formation from atmospheric reactions is an important tool in understanding current and future impacts of human activity on the environment. Vapor pressure is a key parameter in modeling this process, as it largely determines partitioning of products from the gas to particle phase. However, the vapor pressures of many atmospherically relevant compounds are still poorly constrained. To aid modeling efforts, several group contribution methods have been developed for estimating compound vapor pressures. The current study evaluates how four of these methods: SIMPOL, EVAPORATION, SPARC, and Nannoolal, impact modeled predictions of SOA yields for reactions of C8-C14 1-alkenes and C9-C15 2-methyl-1-alkenes with OH radicals in the presence of NOx. The models were created in the kinetics modeling software KinSim and include rate constants measured by Atkinson and co-workers, quantitative reaction mechanisms developed by our research group from several previous environmental chamber studies of product yields, gas-particle and gas-wall partitioning, and effective mass accommodation coefficients (Shiraiwa and Pöschl 2021) to account for effects of particle viscosity. Modeled SOA yields were compared to measured values and optimized viscosities were compared to those calculated using AIOMFAC. The large range of agreement exemplifies the impact of vapor pressure and viscosity in modeling atmospheric reactions and indicates the need for further development of estimation methods.

9AC.20

Modeling the Influence of Carbon Branching Structure on SOA Formation of Alkanes. AZAD MADHU, Myoseon Jang, *University of Florida*

Branched alkanes represent significant proportions of hydrocarbon emissions in urban environments and are important to be considered with regard to Secondary Organic Aerosol (SOA) formation. However, the prediction of the SOA formation from branched alkanes is complex due to the variety in carbon lengths and branching structures. In this study, the Unified Partitioning Aerosol Phase Reaction (UNIPAR) model, which can predict SOA mass via multiphase reactions of hydrocarbons, is extended to simulate the SOA formation of various branched alkanes. SOA simulations with the UNIPAR model require a product distribution which is created by lumping explicitly predicted products according to their volatility and reactivity. In order to account for the large variation in branched alkane structures, the lumping array was predicted as a function of carbon lengths and branching ratios in the model. The product distribution of each branched alkane was constructed using an existing array of the linear alkane with the closest vapor pressure. In addition to causing a decrease in vapor pressure, increasing the branching ratio of an alkane can also decrease the ability of alkanes to undergo autoxidation reactions, which serves to reduce both the formation of low-volatility products and SOA yields. An autoxidation reduction factor, as a function of branching ratio, is applied to the lumped groups within the product distribution array which include autoxidation products. The resulting product distributions are then applied to predict branched alkane SOA formation using the UNIPAR model and compared to SOA data generated in an outdoor photochemical smog chamber. Additionally, the SOA formation from branched and linear alkanes in diesel fuel was simulated to show the relative importance of anthropogenically emitted branched and linear alkanes within a wide range of carbon numbers.

9AC.21

Exploring the Role of Hydroperoxyl Radical in the Multiphase Organic Aerosol Aging. WEN ZHANG, Haofei Zhang, *University of California, Riverside*

Organic aerosols (OA) ubiquitously exist in the atmosphere and their heterogeneous oxidative aging can significantly impact air quality, climate change and human health. Hydroperoxyl radicals (HO2·) are important gas-phase oxidant in the troposphere along with hydroxyl radicals (·OH) and are known to play a key role in gas-phase organic compound oxidation chemistry. However, it is unclear how HO2· affect heterogeneous OA oxidation kinetics and the aerosol composition through aging. In this study, we carry out •OH-initiated heterogeneous aging of oxygenated OA model systems by using a flow tube reactor (FTR). HO2· concentrations are controlled in these experiments. We explore the heterogenous aging kinetics of OA model systems with the HO2·/·OH concentration ratios of 10-1 – 102 using a thermal desorption chemical ionization mass spectrometer (TD-CIMS). Besides, we use an ion mobility spectrometry mass spectrometer (IMS-MS) and a gas chromatography mass spectrometer (GC-MS) to characterize the aged OA chemical composition and detect key oxidation products under various HO2· conditions. Our results suggest that the presence of HO2· may affect both OA aging kinetics and composition through complex processes.

9AC.22

Conversion of Organic Sulfur from Hydroxymethanesulfonate (HMS) to Inorganic Sulfur Species upon Heterogeneous OH Oxidation. Donger Lai, Yee Ka Wong, Rongshuang Xu, Sinan Xing, Sze In Madeleine Ng, Lin Kong, Jian Zhen Yu, Dan Dan Huang, MAN NIN CHAN, *The Chinese University of Hong Kong*

Hydroxymethanesulfonate (HMS) has been found to be an important organosulfur compound in atmospheric aerosols. Recent laboratory studies have revealed heterogeneous OH oxidation of organosulfur compounds can generate inorganic sulfates. However, reaction kinetics, products and mechanisms for such sulfur conversion from its organic form to inorganic counterparts upon oxidation of organosulfur compounds remain unclear. We investigated the heterogeneous OH oxidation of sodium hydroxymethanesulfonate (Na-HMS) using an oxidation flow reactor (OFR) by measuring the decay of HMS and the formation of inorganic sulfur species upon oxidation using ion chromatography (IC). Kinetic data show that the oxidation is efficient with an effective OH uptake coefficient, γeff of 0.35 ± 0.03. The conversion from organic sulfur from HMS into inorganic sulfur species can be well accounted by the formation of bisulfate, sulfate, and peroxydisulfate upon oxidation. A kinetic model is developed to simulate the formation and evolution of reaction products during oxidation. Model results suggest that the decay of HMS and the formation of inorganic sulfur species can be well explained by a series of aerosol-phase chain reactions triggered by sulfite anion radical. Overall, our results suggest a significant conversion of organic sulfur from HMS to inorganic sulfur species, in particular peroxydisulfate ion upon heterogeneous OH oxidation.

9AC.24

Predictions of Secondary Organic Aerosol Formation from Consumer Products. HUAWEI LI, Qi Li, David R. Cocker III, *University of California, Riverside*

The efforts of regulatory agencies to improve air quality by reducing traditional sources of emissions, including traffic and industrial emissions, have led to large improvements in air quality. However, the remaining challenge of secondary organic aerosols (SOA) is still non-negligible. Recent studies have shown volatile chemical products (VCPs) emerging as the largest petrochemical source of urban organic emissions, particularly in the Los Angeles area, where VCPs usage accounts for only 4% of all petrochemical products but contributes more than half of the urban volatile organic compound emissions. Therefore, it is urgent to systematically study the SOA formation of VCPs and their chemical ingredients.

This study characterized SOA formation from VCPs (e.g., personal care products and household products) and SOA precursors that are emitted from the selected VCPs. The objective precursors were selected based on their chemical ingredient and potential importance to SOA formation. The SOA formation from both the VCP and the individual ingredients were investigated and the total SOA formation of the ingredients compared to that of the VCP itself. Experimental results indicate that both the hair shampoo mixture and selected single chemical ingredients produce notable amounts of SOA. It was observed that the chemical processing of the ingredients to form the product strongly influenced the SOA formation of VCPs compared to its ingredients. Therefore, it is important to further investigate the formation of secondary aerosols from personal care products and household products to better understand their impact on air quality. The resulting datasets will be used to evaluate and improve the understanding of SOA formation from VCPs that are used in regulatory applications.

9AC.25

Organic Nitrates Regulate the Production of Urban Secondary Organic Aerosol and Ozone. JUNFENG WANG, Jianhuai Ye, Hong Liao, Jie Zhang, Ke Li, Xinlei Ge, Daniel Jacob, *Nanjing University of Information Science and Technology*

Anthropogenic emissions of NOx and the presence of organic nitrates (ONs) affect the formation of atmospheric secondary organic aerosol (SOA) and ozone (O_3). However, the underlying mechanisms, especially the roles of the gas and particle-phase ON species, remain poorly understood. Herein, a field campaign conducted in urban Beijing is described for the investigation of the mechanisms by which ONs affect the production of SOA and O_3 in summer. The measurements show that there were high concentrations (>40 ppb) of total reactive nitrogen reservoir species during nighttime. They arose from the oxidation of anthropogenic emissions by NO3 and consisted mainly of gaseous alkyl nitrates. These species produced in the night promoted particle growth and O_3 production the following day.

9AC.26

Scrambling of Molecular Speciation of Gaseous Oxidized Mercury via Surface Reactions on Atmospheric Aerosols.

ALEXEI KHALIZOV, Na Mao, *New Jersey Institute of Technology*

Mercury enters the aquatic and terrestrial environments primarily via the deposition of atmospheric gaseous oxidized mercury, Hg(II). The original Hg(II) is produced by photochemical oxidation of elemental gaseous mercury and our knowledge of its molecular composition is limited, coming primarily from quantum chemical calculations. Atmospheric aerosols represent a significant sink for Hg(II) and there is a possibility that the reactions on/in aerosol particles may lead to changes in the molecular speciation of Hg(II).

We investigated interactions of a series of Hg(II) compounds with each other and with other chemicals under conditions that simulate the processing of Hg(II) by atmospheric aerosols. The reactions were studied in aqueous solutions and on surfaces, and the products were analyzed in the gas phase (by ion drift - chemical ionization mass spectrometry), in solution (by electrospray ionization - mass spectrometry), and on surface (by Raman microscopy). In most cases, we observed a rapid formation of Hg(II) exchange products, which readily volatilized into gas phase at room temperature. We propose that a similar gas-particle exchange reactions may occur in the atmosphere, where the original Hg(II) species (e.g., BrHgONO and HOHgOOH) would react with each other and with particle constituents to form different Hg(II) substances. For instance, a readily volatilizable $HgCl_2$ can be produced through the exchange of the originally low-volatility Hg(II) with the particle-phase chloride. The occurrence of such exchange reactions can scramble the original molecular speciation of Hg(II) on a time scale from hours to a day, affecting our ability to predict the transport and deposition of atmospheric mercury, as well its further transformations and bioaccumulation in the aquatic and terrestrial environments.

9AC.27

Seasonal Variation of Fine Particulate Matter-Bound Toxic Metals in a Typical South Asian Industrial City.

MUHAMMAD IBRAHIM, Afifa Aslam, Abid Mahmood, *Government College University Faisalabad, Pakistan*

Atmospheric particulate matter is recognized as a potential source and probable impact on human health. Faisalabad is an industrialized city in Pakistan and contains prime interest when it comes to the quality of ambient air. The current study mainly proposed to measure the concentration of toxic metals in $PM_{2.5}$ particulates in the ambient air of Faisalabad, Pakistan to attain the interest of policymakers and government institutes to address this issue of air pollution in Faisalabad. Samples of fine particulate matter were collected on a 24-hours basis using a high-volume air sampler in the winter of 2016 and summer of 2017. Potentially toxic metals, including Al, Cd, Zn, Cr, Mn, Cu, Ni, Na, Pb, and Fe, were analyzed to study their levels and size distribution through Atomic Absorption Spectrometry (AAS), Flame unit. At all the sampling sites, Al (42.283 $\mu g/m^3$) was found in the utmost concentration due to the Al smelting in the study area followed by Fe, Na, Zn, Pb, and Cu. The cadmium (0.002 $\mu g/m^3$) and chromium (0.338 $\mu g/m^3$) were found in moderate to high concentration, while, Mn and Ni were found in low concentration. While moderately strong to highly strong Pearson's correlation was observed between $PM_{2.5}$ and almost all the selected metals. The main sources contributing to toxic metals in the air of Faisalabad city were recognized by principal component analysis: industrial and vehicular emission, soil dust, and road re-suspension dust.

9AC.28

Determination of Intermediates of the UO2F2 Aerosol Formation under Different Water Conditions. CHRISTIAN MARK SALVADOR, Jason Richards, Shannon Mahurin, Meng-Dawn Cheng, *Oak Ridge National Laboratory*

Uranyl fluoride (UO_2F_2) is produced in gas-phase UF6 hydrolysis. Understanding the particle formation of UO_2F_2 is critical for nuclear forensics. Formation of the uranyl aerosol requires the production of several precursors or intermediate species. Here, we probed the production of the intermediates using a Molecular Beam Mass Spectrometer (MBMS). UF_6 (200 ppm) and water vapor (300 ppm and 3000 ppm) were flown at 1.0 LPM each in separate gas-phase hydrolysis experiments. Triplicate analyses of each condition were run to ensure the reliability of the peaks observed from the reaction products. More than 15 masses showed significant enhancement (>30%) compared to the baseline condition. Interestingly, four common peaks (m/z 79, 81, 96, and 634), were found in the two reaction conditions, suggesting possibly different reaction pathways. The masses < 100 m/z were attributed to $(HF)_3F$, $(HF)_4$, and $(H_2O)_2\cdot(HF)_3$, which are the expected HF clusters generated from the hydrolysis. The overall peaks were classified into four groups: Water/HF clusters: $[(H2O)_2\cdot(HF)_6F)]$ monomers:$[(UF_5OH\cdot(HF)_4\cdot F$, $UF_5OH\cdot(H_2O)_6\cdot(HF)_3$ and $(UF_5OH)\cdot(HF)_2\cdot(H2O)_4)]$, dimers:$[(UO_2F_2)_2\cdot H_2O$, $(UF_5OH)\cdot(UO_2F_2)\cdot H_2O$, and $(UF_5OH)_2\cdot(HF)_2]$ and trimers:$[UF_5\cdot UO_2F_2\cdot UO_2F_2$, $UF_5\cdot UO_2F_2\cdot UO_2F_2$, and $UO_2F_2\cdot U_2O_2F_9H]$. This is the first time that molecules embedded with the UF_5OH core was experimentally discovered, although the possibility of this structure being part of the reaction intermediates was suggested previously by computational modeling about 5 years ago. The reaction pathways of the intermediates and their implications in different water vapor conditions will be discussed in the presentation.

9AC.30

Investigating the Effect of Temperature Cycles on Gas-Particle Phase Transitioning in Dark Ozonolysis Systems. DANIEL GONZALEZ, Chen Le, Ryan W. Drover, Huawei Li, Yanyu Zhang, Thomas Eckel, David R. Cocker III, *University of California, Riverside*

This study investigates the impact of temperature cycles, after the formation of Secondary Organic Aerosol (SOA), in two dark ozonolysis systems: α-pinene and cyclohexene. The study challenges the conventional assumption that particle-gas phase partitioning is completely reversible during temperature cycles. The results reveal that temperature has a significant effect on SOA formation and highlights the need for improved understanding of the role of temperature in particle-gas phase partitioning and compound specific SOA formation. This understanding is essential for accurate modeling of atmospheric processes and air quality management strategies.

The study design is robust, with a multi-day indoor environmental chamber experiment conducted for the α-pinene system, and thermal cycling experiments performed for several consecutive days within a temperature range of 5 – 35°C. The α-pinene system exhibited consistent reversibility of gas-particle phase transitions upon repeated temperature cycling, while the cyclohexene system showed an irreversible loss of mass after the first temperature cycle, with consistent reversibility observed during subsequent temperature cycles. These findings, coupled with observations of the chemical (e.g., H:C, O:C, f43/f44) and physical nature (e.g., size, density, volatility) of the suspended aerosol, highlight the complex nature of atmospheric processes and the importance of understanding the impact of temperature on SOA formation.

9AC.31

Quantifying the Impact of Agricultural Ammonia Increases on Particulate Matter Burden over the Midwestern United States.

TOAN VO, Amy Christiansen, *University of Missouri - Kansas City*

Over the past few decades, ammonia (NH_3) emissions have strongly increased in the highly agricultural Midwestern United States (MWUS). Ammonia serves as a key precursor species in the formation of fine particulate matter ($PM_{2.5}$), which impacts human health and Earth's climate. However, NH_3 emissions are not regulated at the federal level, and the impacts of agricultural NH_3 to air quality in urban areas are not well quantified. The goal of this work is to determine the impact of increasing agricultural NH_3 on nitrogen deposition and the formation and chemical composition of $PM_{2.5}$ from 2007 to 2019 through GEOS-Chem model simulations and observational data from the Ammonia Monitoring Network (AMoN), Clean Air Status and Trends Network (CASTNET), and the Interagency Monitoring of Protected Visual Environments (IMPROVE) throughout the MWUS. We find significant increases in NH_3 of >50% on average across the MWUS region for all seasons, especially during winter, where most of the sites in the MWUS exhibit > 100% increases. Wet deposition of NH_4^+ increases by>75% during summer, fall, and winter. Additionally, the contribution of NH_4^+ to total nitrogen deposition increased from 35% in 2007 to >50% in 2019. Although overall $PM_{2.5}$ concentrations have decreased by >50%, NH_4^+ makes up >50% of the particle mass in the MWUS, which is on average 25% higher than in the rest of the United States, indicating ammonia emissions are a contributing factor to changes in particle chemical composition. Finally, we discuss the impact of increasing agricultural NH_3 on $PM_{2.5}$ in the MWUS and downwind areas using sensitivity simulations in the chemical transport model GEOS-Chem, and we quantify the $PM_{2.5}$ burden attributable to agricultural NH_3. Overall, this work joins the growing body of literature suggesting NH_3 emissions should be regulated federally to reduce $PM_{2.5}$ formation and protect public health.

9AC.32

Comparisons of Aqueous SOA Products and Physical Properties in Methylglyoxal/Ammonium-Sulfate Solutions under Dark and Irradiated Conditions.

ERIN O'LEARY, Maia Merriman, Katherine Pierre-Louis, Bruno Loyola San Martin, Joseph Woo, *Lafayette College*

Methylglyoxal (MG) is a carbonyl-containing volatile organic compound that has been identified to be present in ambient aqueous aerosols under a variety of atmospherically relevant contexts. Recent work exploring the physical properties and aqueous-phase processing of aerosol mimics containing MG and ammonium sulfate (AS) have suggested the presence of multiple potential pathways for secondary organic aerosol (SOA) formation in the MG/AS reaction system under both dark (nighttime) and UV-irradiated (daytime) conditions. The surface-active nature of MG/AS reaction products have suggested that high surface/volume ratio systems, such as those in aerosols, may affect relative SOA yields due to locally-high reactants at the gas/liquid interface, resulting in higher-molecular-weight oligomers that would otherwise not be possible in bulk solution. This work compares the relative yields of irradiated MG/AS reaction products under bulk, µL-scale hanging-droplet, and aerosolized conditions. Surface tension, UV/visible absorbance, and ESI-MS data are reported. Reaction products of aged, aerosolized MG/AS solutions are compared without light exposure, with UV-A irradiation, and with UV-C irradiation.

9AC.33

Investigating the Significance of Water Associated With Organic Matter Towards Atmospheric Aerosol Liquid Water Content in Florida. MEGAN NEUMANN, Marwa El-Sayed, Shannon Capps, *Embry-Riddle Aeronautical University*

Aerosol liquid water content (ALWC) is ubiquitous in the atmosphere and is influenced by relative humidity, as well as inorganic and organic aerosol concentrations and their composition. However, the contribution of organic versus inorganic aerosol towards ALWC is highly uncertain at present. While some studies report the negligible contribution of organic aerosol to the concentration of ALWC, others provide evidence for a contribution of organic aerosol similar to that of inorganic aerosol. Hence, the aim of this study is to determine the contribution of organic aerosol to the concentrations of ALWC under contrasting environmental conditions in Florida across different seasons. Organic and speciated inorganic concentrations of fine particulate matter (PM2.5) were provided by the Florida Department of Environmental Protection, and assessed through the U.S. Environmental Protection Agency Air Quality Database, at three sites during 2017-2022. Gaseous concentrations of ammonia and nitric acid were acquired from the EPA's CASTNET network during the same period. Water associated with inorganic aerosol (Winorg) was calculated using the hyperdual version of ISORROPIAv2.1 aerosol thermodynamic equilibrium model. Concentrations of aerosol inorganic composition (Na+, NH4+, K+, SO42-, Mg2+, Ca2+, NO3- and Cl-), temperature, and RH as well as nitric acid and ammonia gaseous concentrations were input to calculate partitioned inorganic concentrations and ALWC as well as sensitivities of each of these concentrations to the sum of the aerosol and gaseous concentrations. The liquid water associated with organics (Worg) was calculated based on organic concentrations, meteorological data, and hygroscopicity assumptions based on the kappa-Kohler theory. The total ALWC was thus calculated as the sum of the liquid water associated with inorganic and organic aerosol constituents. These analyses will provide insight into the significance of organic matter towards ALWC in the atmosphere with implications for the accurate representation of ALWC in models.

Keywords: Aerosol Liquid Water Content, ISORROPIA 2, organic aerosol, inorganic aerosol, air quality monitoring.

9AC.34

Real-Time Aerosol Mass Spectral Characterization of Aerosols Generated by an Electronic Nicotine Delivery System (ENDS) and Aerosolization of Surrogate E-Liquids as a Function of Humectant Composition and Heating Power. Yue Zhang, JIN YAN, Nicolas Aliaga Buchenau, Manjula Canagaratna, Caz Nichols, Michelle McCombs, Timothy Fennell, Elena Mishina, Samanthan Reilly, Marcella Ferlito, Kamau Peters, Jonathan Thornburg, Jason Surratt, *University of North Carolina at Chapel Hill*

Electronic nicotine delivery systems (ENDS) heat and aerosolize e-liquids, generating a chemical mixture mainly composed oRf propylene glycol (PG), vegetable glycerin (VG), nicotine, and flavoring agents. The health risks associated with inhalation of aerosolized PG and VG mixtures and their thermal-degradation products remain a concern. Prior studies identified the chemical constituents of ENDS-derived aerosols using offline chemical characterization methods, which can be prone to artifacts. Real-time chemical composition of ENDS-derived aerosols can resolve the temporal distribution of aerosols to accurately quantify human exposure. In this study, we examined the real-time ENDS-derived aerosol composition using on-line analytical methods and compared it with data from offline chemical analyses.

We aerosolized e-liquids with five PG:VG volume fractions ranging from 0 to 100% with a KangerTech NRMesh atomizer device at power settings of 20, 60, and 100 Watts. The ENDS aerosols were 1) sampled by a real-time aerosol chemical speciation monitor (ACSM), and 2) collected onto Cambridge filter pads for offline chemical analysis using hydrophilic interaction liquid chromatography method coupled to high-resolution quadrupole time-of-flight mass spectrometry equipped with electrospray ionization (HILIC/ESI-HR-QTOFMS). The ACSM mass spectra contained tracer ions unique to PG and VG, and positive matrix factorization (PMF) methods estimated the fraction of PG and VG. Both on-line and offline analyses showed that ENDS-derived aerosols are dominated by VG due to its lower vapor pressure. Higher power was correlated with an enhanced ratio of ions with $m/z > 104$, consistent with elevated oligomer content from offline chemical analysis. A recent indoor air study using aerosol mass spectrometry with PMF methods found a factor associated with ENDS usage and had a similar profile to ENDS-derived aerosols in our study. These results highlight that the ACSM can be applied in situations where accurately quantifying the composition and temporal trend of ENDS aerosols are needed.

9AC.35

Isoprene Peroxy Chemistry Operates Competitively in Areas of East China. XUAN ZHANG, *National Center for Atmospheric Research*

We validated the recently updated Caltech Isoprene Mechanism (CIM), which represents the complex dynamics of isoprene peroxy isomers through repetitive O2 addition and dissociation reactions, using a dataset synthesized from two field measurements taken place in both urban and rural areas of East China. The dataset covers a large span of nitric oxide (NO) levels ranging from tens of ppt characteristic of clean rural air to tens of ppb typically found in the polluted urban environment. An observationally constrained zero-dimensional box model that incorporates the CIM mechanism was constructed to simulate the daytime profiles of methacrolein (MACR) and methyl vinyl ketone (MVK), two major first-generation products that account for over half of the total carbon oxidation flow of isoprene. A closer agreement with the measurements was found compared with the traditional mechanism that prescribes a fixed yield of MACR and MVK across all NO levels. This result demonstrates that the isoprene peroxy dynamics operate competitively in the area and play a governing role in the final distribution of isoprene oxidation products. The atmospheric implication is that, with effective measures taken to reduce pollutant emissions in East China, the prevailing chemical regime at play has evolved and implementing the updated isoprene mechanism into regional models will have a profound impact on the predicted radical cycling and ozone production of the local atmosphere.

9AC.36

Aerosol Organic and Inorganic Composition on Sunny and Cloudy Days during EPCAPE. SANGHEE HAN, Abigail Williams, Veronica Berta, Jeramy Dedrick, Christian Pelayo, Nattamon (Jeep) Maneenoi, Lynn Russell, *University of California, San Diego*

Aerosol composition in the atmosphere can be significantly affected by two distinct secondary processes: photochemically-driven reactions on sunny days and aqueous reactions on cloudy days. Sunlight drives photochemical reactions that initiate atmospheric oxidation processes of reactive organic gases. On cloudy days, both organic and inorganic atmospheric trace gases are absorbed by cloud droplets, allowing in-droplet chemical reactions. These secondary processes closely relate to the physicochemical properties of both gas and particle compounds in the ambient air. The Eastern Pacific Cloud Aerosol Precipitation Experiment (EPCAPE) provides Aerosol Mass Spectrometer and Fourier Transform Infrared measurements of aerosol composition in the coastal area of La Jolla, CA, from February 2023 to February 2024. This year-long study included frequent northwesterly winds that provided an opportunity to investigate sunny and cloudy conditions with similar upwind aerosol sources.For the first two months of the campaign, there were 17 sunny days and 18 cloudy days. Overall, organic aerosols were the largest fraction of non-refractory mass concentration, constituting 60%, followed by nitrate (18%) and sulfate (16%). On sunny days, organic aerosol fragments accounted for approximately 67% of non-refractory mass concentration, while on cloudy days, this fraction decreased to 52%. Nitrate and sulfate contributed higher fractions of non-refractory submicron mass concentration (21% each) on cloudy days compared to sunny days (14% and 11%, respectively). These analyses are important for characterizing the aerosol interactions with cloud processes, which contribute to the improvement of climate and air quality models.

9AE.1

Environmentally Persistent Free Radical Formation and Correlation with Ambient Pollutants in Fairbanks, Alaska during the ALPACA Campaign. KASEY EDWARDS, Sukriti Kapur, Ting Fang, Meeta Cesler-Maloney, Yuhan Yang, Ellis Robinson, Peter F. DeCarlo, Rodney J. Weber, William Simpson, Manabu Shiraiwa, *University of California, Irvine*

Environmentally Persistent Free Radicals (EPFRs) play an important role in chemical transformation of atmospheric aerosols and may cause adverse health effects due to their redox activity to produce reactive oxygen species (ROS). EPFR production and stabilization can be enhanced by environmental factors such as the presence of metals, combustion sources, and photochemistry. This study investigated the generation of EPFRs within a subarctic climate from ambient outdoor samples collected in Fairbanks, Alaska as part of the Alaskan Layered Pollution and Chemical Analysis (ALPACA) Campaign. Subarctic conditions in Fairbanks including reduced temperature and daylight hours may also affect the formation of particulate matter and chemical processes in the atmosphere. Daily EPFR concentrations were determined using EPR analysis of collected PM2.5 samples. A high volume Tisch PM2.5 sample collected filter samples for 23.5 hours daily. EPFR concentrations were on average 18±12 pmol m^{-3}, ~1.5 times higher than suburban concentrations but ~2 times lower than that found near a Southern California highway. EPFR concentrations in Fairbanks were found to equate to smoking one cigarette every two days in the winter. EPFR concentrations were well correlated with primary pollutants including carbon monoxide, nitrogen oxides, sulfur dioxide, and potassium (> 0.7 R^2), indicating that EPFRs were associated with incomplete combustion and traffic emissions. EPFRs were found to be anti-correlated with O3 (> 0.6 R^2). They were also found to correlate well with iron and titanium (> 0.6 R^2), which is consistent with previous studies showing that EPFRs can be stabilized by transition metals. When looking at correlations of EPFR molar concentrations per particle mass, NOx remained the highest correlation, although substantially lower (> 0.3 R^2). Our results indicate that although traffic and combustion sources are mostly likely the primary sources of EPFR generation, meteorological conditions strongly influence EPFR concentrations.

9AE.2

Uptake Rates of PDMS-Based Passive Sampling Materials for Aerosols with Varying Particles Sizes. DONG GAO, Elizabeth Lin, Jonathan Martin, Krystal Godri Pollitt, *Yale University*

Passive sampling using sorbents is an economical and versatile method of measuring air pollutants. Airborne particles can be collected onto passive samplers by gravity, impaction, and diffusion, following theories of particle deposition velocities according to particle sizes. However, the passive samplers may not effectively capture particles in all size ranges, and the uptake rate of sampling materials for aerosols with different sizes remains poorly understood, limiting their utility in quantifying exposure levels. In this study, we investigated the uptake rates of three polydimethylsiloxane (PDMS)-based passive sampling materials –PDMS foam, PDMS tubes, and XAD-coated PDMS tubes – for aerosols with varying sizes. We generated polydisperse fluorescent calibration aerosols centered on different geometric mean sizes to better simulate real-world conditions and exposed the sampling materials to these aerosols in a controlled chamber environment. Aerosol concentrations and size distributions were monitored during exposure with an optical particle counter. After exposure, the total volume of particles captured by each sampling material was quantified by measuring the collected fluorescence, and the overall uptake rate was then calculated. Our results show that the uptake rates were size-dependent and varied between the different PDMS-based passive sampling materials. The PDMS foam exhibited the highest overall uptake rate, possibly due to the enhanced surface area given its porous structure, followed by PDMS tubes and XAD-coated PDMS tubes. This study provides insights into the performance of PDMS-based materials for sampling aerosols with different sizes, which could aid in estimating levels of exposure to aerosols or aerosol constitutes using passive sampling techniques.

9AE.3

Understanding Heterogeneity and Sources of Black Carbon and Volatile Organic Compounds in Residential Neighborhoods of New York State Capital Region and Hudson Valley Region.

SANCHITA PAUL, Marco Eugene, Farid Barak, Md. Aynul Bari, *University at Albany, SUNY*

In the U.S., community air quality observation networks are limited in characterizing the diverse group of air pollutants e.g., black carbon, VOCs that affect exposure across regional to neighborhood scales. The NYS Capital Region is a metropolitan area (population more than 1 million inhabitants), where Albany and Saratoga counties have been experiencing declining air quality grades in the recent years. While the Hudson Valley region is an industrial hub and is known for several air quality issues e.g., residential wood smoke pollution and industrial emissions. This study aims to understand the spatiotemporal variability of climate forcing agents such as black carbon and pollutants of public health concern e.g., VOCs in residential neighborhoods in NYS Capital Region and Hudson Valley Region. The study used low-cost sensor technologies to measure indoor and outdoor concentrations of black carbon, in at least 60 homes during the winter and spring seasons over the period November 2021-May 2023. Data on meteorological parameters e.g., outdoor wind speed and wind direction relative humidity, temperature, as well as questionnaire-based housing characteristics, and occupants' activities were also collected for each home. Results showed significantly higher black carbon concentrations outdoors (backyards) than indoors (living room), suggesting an influence of potential local sources. Significant variations in indoor concentrations were also observed among neighborhoods depending on the location of homes. The study also used cost-effective techniques to measure speciated VOCs for source analysis both indoors and outdoors in at least 20 homes across the study region. The findings of this study will provide insights into the potential health risks associated with exposure to indoor and near-field outdoor air pollution. Findings can benefit the general people to improve their knowledge, raise awareness and empower communities to take actions and/or inform policy makers to improve indoor air quality and public health.

9AE.4

Secondhand Electronic Cigarette Aerosol in Vehicles Impacts Indoor Air Quality.

Eric Soule, SINAN SOUSAN, Jack Pender, Luke Thomas, Emily Gold, Sarah Fresquez, Ronald Mooring, Vivien Coombs, Anish Gogineni, Alex Tiet, *Department of Public Health, East Carolina University*

Indoor electronic cigarette (ECIG) use has increased in recent years. ECIG use in vehicles represents public health concern due to the potential for particulate matter (PM) concentrations to increase rapidly from use in a small space. This study examined the impact of ECIG use on air quality in vehicles. Current ECIG users (n=60; mean age=20.5, SD=2.3) completed a brief survey and a 30-minute ECIG use session in their own vehicle. Using their own ECIG device, participants first completed a 5 minute 10-puff directed bout (30-second interpuff interval) followed by a 25-minute ad libitum bout in which participants could take as many puffs as desired, with total puff counts recorded. PM 2.5 µm in diameter or smaller ($PM_{2.5}$) were measured using aerosol monitors set up to sample air from the breathing zone of the passenger seat. The association between peak filter corrected $PM_{2.5}$ concentrations and puff count were examined. During the session, participants took a median 18 total puffs (i.e., 10 during the directed bout and 8 during the ad libitum bout). Median filter corrected $PM_{2.5}$ concentrations increased from 4.78 $\mu g/m^3$ at baseline to 107.40 $\mu g/m^3$ after the directed bout. Median peak filter corrected $PM_{2.5}$ concentration was 464.48 $\mu g/m^3$ and ranged from 9.56 $\mu g/m^3$ to 143,503.91 $\mu g/m^3$ (IQR=132.72-1,604.68). After removing two extreme outliers for puff count and $PM_{2.5}$ concentrations, puff count was significantly correlated with peak filter corrected $PM_{2.5}$ concentration during the ad libitum bout (r=0.32, p=0.015).

9AE.5

Impacts on Urban PM2.5 and VOCs during a Wildfire Episode.

ZHONG-MIN WANG, Ping Wang, Jeff Wagner, Kazukiyo Kumagai, *California Department of Public Health*

This study focuses on the impact of wildfire smoke emissions on regional air quality. Specifically, we measured fine particulate matter (PM2.5) and volatile organic compounds (VOCs) before and after the Butte County Camp Fire (California) of November 2018. Ambient air in the San Francisco Bay Area was monitored and sampled using a beta attenuation monitor (BAM), open face passive samplers (OFPS), and thermal desorption tubes to assess PM and VOCs during the wildfire episode and a later non-wildfire period. OFPS-collected PM was analyzed using Scanning Electron Microscopy/Energy Dispersive X-ray Spectroscopy (SEM/EDS) for detailed morphology and elemental composition. VOCs were analyzed and quantified using Thermal Desorption-Gas Chromatography/Mass Spectrometry (TD-GC/MS). The highest daily average BAM PM2.5 during the fire period was 200 mg/m3 and the highest hourly average was 270 mg/m3. The daily average of BAM PM2.5 in the Bay Area during the wildfire episode was 102 mg/m3. Electron microscopy analysis of the OFPS samples revealed organic carbon tar balls. Elevated concentrations of VOCs such as 1,3,5-Trimethylbenzene (0.33±0.01 mg/m3), Benzene (1.03±0.02 mg/m3), Toluene (2.15±0.04 mg/m3), Ethylbenzene (0.60±0.02 mg/m3), and m, p-Xylene (0.77±0.07 mg/m3) were observed in the wildfire episode. These VOC levels were several times higher than the non-fire period and may potentially pose a public health concern. Monitoring gas phase species in addition to PM concentrations is useful during wildfire season to protect public health.

9AE.6

Generation and Characterization of Reference Ultrafine Soot Particles to Carry Out Toxicological Assessments at the Air-Liquid Interface System.

ANUSMITA DAS, Jana Pantzke, Arūnas Meščeriakovas, Nadine Gawlitta, Seongho Jeong, Natalia Ivleva, Mathilde Delaval, Simone Schmitz-Spanke, Sebastiano Di Bucchianico, Jürgen Schnelle-Kreis, Martin Sklorz, Ralf Zimmermann, *Helmholtz Zentrum München and University of Rostock*

Ultrafine particles (UFP, Dp ≤100 nm) are discussed to be involved in the global burden of disease associated with air pollution. It is not fully understood to what extent the physical properties of UFP contribute to their toxicity or whether the particles act primarily as carriers of biologically reactive chemicals, that are responsible for the biological responses. Thus, addressing such questions in toxicological testing requires robust methods for the generation and manipulation of UFP, that allow the physical and chemical parameters of UFP to be adjusted in a targeted and reproducible way. Herein, we focused on the production and characterization of soot UFP with similar elemental carbon cores and similar physical properties but different chemical constituents. The primary soot particles were generated with a Mini CAST burner at fuel-rich conditions (λ=0.80) and immediately diluted by an adjustable porous tube diluter and 10-fold fixed ejector diluters to reduce agglomeration. A catalytic stripper followed by a multichannel activated-charcoal denuder was used to strip off volatile/semi-volatile components. Depending on the temperature of the catalytic stripper, two types of UFP soot were produced: UFP with high semivolatile organic content (T=30°C) and UFP with low semivolatile organic content (T=350°C). Physical characterization showed that both had similar mobility diameter (≈45nm), number (≈5e05/cm^3) and mass concentrations (≈100µg/m^3) along with similar Black Carbon content (eBC≈50µg/m^3) and the same morphology. Filter samples were taken to characterize the chemical composition. Elemental and organic carbon content, polycyclic aromatic hydrocarbons were quantified. The generated aerosols were further assessed for biological responses in human alveolar epithelial cells at the air-liquid interface. The toxicological assessments investigated effects on the cellular metabolic activity, cytotoxicity, genotoxicity and xenobiotic metabolism. Furthermore, repeated cell-exposures were enabled to produce and adjust specific UFP attributes with demonstrated reproducibility for toxicological studies.

9AE.7

Intake Fraction Associated with Indoor Particle Sources: Effects of Source Location and Ventilation Conditions.

Donghyun Rim, YESEUL EOM, *Pennsylvania State University*

Human exposure to indoor aerosols varies with source location and ventilation conditions. Several studies have revealed that indoor airflow and ventilation conditions have notable effects on human exposure. However, there are few studies quantitatively evaluating how human exposure to indoor aerosols varies with source location and ventilation conditions. The objective of this study is to (1) investigate the relationship between intake fraction and ventilation conditions; (2) evaluate the indoor particle concentration distribution in the micro-environment surrounding a human body depending on the source location. Computational fluid dynamics (CFD) simulation was conducted to predict the particulate pollutant transport around a human body in a ventilated room. We investigated transport aerosols of two sizes : (1) 1.0 µm particles, which fall in the fine particle range; and (2) 10 µm particles, which represent respirable coarse particles. Intake fraction around human body was evaluated under two ventilation conditions: (1) mixing and (2) displacement ventilation. The results showed that particle concentration in the breathing zone widely varies with source location and ventilation conditions. Relative to the mixing ventilation, the intake fraction for the displacement ventilation increased notably for particles released from the face region. For the source released from the floor region, spatiotemporal particle concentration gradients were pronounced when particle size was 1 µm with displacement ventilation. The results of this study provide the relationship between ventilation conditions and indoor exposure relative to the concentrations in the breathing zone under representative indoor ventilation conditions.

9AE.8

Optimizing Aerosol Distribution in Allergen Exposure Chambers: A Comprehensive CFD Study.

FATEMEH RAZAVI, Laura Haya, Suzanne Kelly, Rachel Friedrich, Alissa Belanger, Jimmy Yang, William Yang, Edgar Matida, *Carleton University*

Allergen Exposure Chambers (AECs, sometimes also referred to in the literature as Environmental Exposure Units, EEUs) are specially designed rooms in which patients can be exposed to airborne allergens for clinical studies. Advantages of AECs include: 1) A controlled environment that avoids pollution and weather conditions, 2) Elimination of other competing allergens (e.g., mold spores) as experiments can be conducted outside the allergy season, and 3) Controlled concentration levels of airborne allergens. Aiming for uniformity in both spatial and temporal distribution of allergens (particularly pollen) in newly designed AECs, numerical studies have been performed to analyze factors such as tower-type oscillating fan configuration, room ventilation rate, exhaust locations, and the allergen dispersion system. The airflow was solved using Unsteady Reynolds-Averaged Navier-Stokes (URANS) equations with a shear-stress-transport turbulence model. The particulate matter was simulated using Lagrangian particle-tracking techniques.

Clean air entered the chamber from the ceiling, while particles representing pollen were introduced at ceiling points and tracked over time. Four oscillating mixing fans placed at each wall of the room were modeled to simulate airflow. The particle volume fraction at the level of participants' heads was analyzed to assess uniformity. The ongoing investigation has revealed the impact of several factors, especially the number and location of ventilation intake diffusers, exhausts, and aerosolizers, on the uniformity of the allergen field, guiding the overall AEC design. Synchronization of fans has also proven crucial for achieving the desired particle dispersion. An efficiency coefficient was introduced to evaluate the particle distribution uniformity, and a tentative AEC configuration has been proposed. Validation of the tentative design in an actual AEC will be performed in a separate investigation.

Keywords: Allergen Exposure Chamber, Computational Fluid Dynamics (CFD), Particle Dispersion, Fan Configuration, Exhaust Locations, Ventilation Rate, Unsteady Reynolds-Averaged Navier-Stokes (URANS), Particle Tracking, Efficiency Coefficient, Allergen Exposure Control.

9AE.9

A Deep Learning-based PM2.5 Forecasting Model for Pittsburgh Using GEOS-CF Based Atmospheric Composition Data.

ABHISHEK ANAND, Albert Presto, Amir Barati Farimani, *Carnegie Mellon University*

Exposure to $PM_{2.5}$ causes around 4.3 million premature deaths globally. Pollution exposure is even higher during the high pollution episodes caused by boundary layer inversions. Decline in vertical mixing during these inversions reduces air pollutant dispersion and consequently traps pollutants close to the surface leading to higher pollution which further promotes formation of secondary pollutants. Therefore, it becomes important to locally predict these high pollution episodes. We build different $PM_{2.5}$ forecast models for Pittsburgh (Allegheny County), including multi-linear regression, machine learning, and deep learning models, and compare their performances to find an optimum forecast model. The models use (i) 5 years of hourly pollutant data ($PM_{2.5}$, CO, CO_2, NO_2) from low-cost sensor network of 50 sites in Allegheny County, (ii) land use parameters (static covariates), (iii) $PM_{2.5}$ and CO from regulatory monitors, (iv) dynamic covariates (temperature, wind and precipitation) and (v) 5-day forecast for O_3, CO, NO_2, SO_2 and $PM_{2.5}$ from Goddard Earth Observing System Composition Forecasting (GEOS-CF) at 25 km × 25 km grid resolution. We observed that the best performing ML model (Gradient boosting) shows a better performance with R^2 of ~0.74 and root mean square error (RMSE) of ~4.2 $\mu g.m^{-3}$ over the multi-linear regression model (R^2 ~0.52; RMSE ~5.3 $\mu g.m^{-3}$). Similarly, the deep learning model (Convolution neural network - CNN) exhibits an improved performance (R^2: 0.81; RMSE: 2.95 $\mu g.m^{-3}$) over the ML model. Different feature reduction techniques were used for the three types of models to identify key features for the forecasting models. We observed improvements in each forecast model's performance by adding GEOS-CF based forecast for pollutants as predictor variables. The deep learning-based $PM_{2.5}$ forecast model can help predict high pollution episodes from boundary layer inversions which can benefit policymakers in responding to these episodes to reduce health exposure.

9AE.10

Spatial and Temporal Variations of Ultrafine Particles in a Residential Area Near an Airport.

CHEOL H. JEONG, Junshi Xu, Weaam Jaafar, Emily Farrar, Danny Anwar, Isaac Nielsen, Matthew Tamura, Marianne Hatzopoulou, Greg J. Evans, *SOCAAR, University of Toronto*

Urban air pollution is a result of a complex interaction between regional and local sources, which can be influenced by various factors such as proximity to transportation infrastructures and local meteorology. An increasing number of studies have shown that people living near major highways and airports are at a higher risk of developing air pollution-related health issues compared to those living further away. Comprehensive measurement and data analysis are crucial to better understand the contribution of different sources to air pollution.

Gaseous and particle phase air pollutants, including ultrafine particles (UFP), black carbon (BC), and criteria pollutants were measured in a residential neighbourhood near an airport and major roads in Toronto. Stationary sampling was conducted in three seasons in 2020 (Jan-Feb, Apr-May, and Jul-Sep). Follow-up measurement was performed at four locations within the neighbourhood from Jun to Aug 2022 to investigate temporal and spatial pollutant variations and compare pre/during/post COVID-19 lockdown levels. Additionally, data from two long-term air monitoring stations located 2.5 km north and south of the community were compared. Air navigation information, such as aircraft types, takeoff, and landing, was analyzed to evaluate the influence of aircraft activities on the levels of UFP and BC in the neighbourhood.

The average concentrations of criteria pollutants such as $PM_{2.5}$ and NO_x in the neighbourhood were found to be similar to other parts of Toronto. However, the concentration of UFP was approximately 3 times higher in the neighbourhood when the wind blew from the airport than in the opposite direction. A steep spatial gradient of UFP was observed, with levels decreasing as the distance from the airport increased. Furthermore, BC levels in the residential area were higher than those at the air monitoring stations. The electrification of the diesel ferry produced benefits in mitigating BC and NO_x in the area.

9AE.11

Design of a Coupled Flame and Cell Exposure System for Study of Combustion Particle Toxicity. SHUBHAM SUNIL SHARMA, Dhruv Mitroo, Shu-Wen You, Joseph V. Puthussery, Rajan K. Chakrabarty, Benjamin Kumfer, *Washington University in St. Louis*

Exposure to particulate matter has been attributed to various health risks, notably asthma, lung cancer, and heart disease. Carbonaceous particles, or soot, emitted from combustion sources have been identified to induce cytotoxicity in various mammalian cells. Both natural events such as wildfires and anthropogenic activities such as driving, cooking, and open waste incineration are significant sources of soot. Soot, depending on its source, can have highly variable physicochemical properties that are relevant to cell health, such as particle size, morphology, surface area, surface reactivity, and composition of associated hydrocarbons including PAHs. Here a single bench top experimental combustion system is presented that selectively produces soot with a wide array of physical and chemical properties to mimic particles generated from specific sources. The system can produce premixed flames and non-premixed flames with normal and inverted configurations. Characterization by electron microscopy, XPS, SMPS, and EC/OC is performed to demonstrate the wide variation that can be achieved with this system. Results from this group indicate that cell viability is significantly sensitive to the flame type and parameters such as flame temperature and equivalence ratio. Traditional cell exposure by addition of a suspension of soot in cell media is challenging due to colloidal instability and difficulty in preserving the original size distribution. To better simulate the mechanism of real-life exposure, an exposure system is being developed that directly exposes cells growing in a standard multi-well culture plate to the flame-generated soot aerosol with controlled deposition to the air/liquid interface. The combined system provides a unique platform for assessing relative toxicity from various sources, and for elucidating the particle properties that are most relevant to health outcomes.

9AE.12

Student Assessment of PM2.5 Concentration at Ecu Transit Bus Stops Using a Low-Cost Aerosol Monitor. WILL MURRAY, Jo Anne Balanay, Sinan Sousan, *East Carolina University*

$PM_{2.5}$ in high concentrations is known to cause respiratory issues, including irritation of the airways, sneezing, coughing, and difficulty breathing. Long-term exposure to $PM_{2.5}$ can have a much more severe effect on individuals with pre-existing conditions such as asthma, chronic obstructive pulmonary disorder (COPD), and heart disease, potentially causing a worsening of the condition, hospitalization, and even death. A primary source of $PM_{2.5}$ is the exhaust and emissions from cars, trucks, and buses. The Environmental Protection Agency (EPA) has in place a daily $PM_{2.5}$ standard of 35 $\mu g/m^3$. College students are not typically regarded as a population that experiences significant $PM_{2.5}$ exposure, but emissions from East Carolina University's transit bus system likely create zones of high $PM_{2.5}$ concentration at ECU bus stops. Seven students who regularly use the ECU Transit system were selected to use a light-weight low-cost $PM_{2.5}$ personal aerosol monitor each time they arrived at a campus bus stop. Student participants repeated this procedure each time they were at an ECU Transit-served bus stop over the course of four weeks. $PM_{2.5}$ concentration data was retrieved remotely from the monitors daily and compared with average EPA measurements for Pitt County, as well as with measurements from a reference instrument, the ADR-1500, located in the same city, Greenville, North Carolina. This methodology allowed for the identification of higher-than-average concentration zones at ECU Transit bus stops compared to average measurements for Pitt County. By increasing access to microenvironmental data, low-cost monitors will contribute to public health efforts of protection and prevention by allowing individuals to measure and understand their exposure to $PM_{2.5}$ at the bus stop. In addition, these monitors will aid commuters, especially those with pre-existing conditions who use public transportation, in making more informed health decisions and better protecting themselves against new or worsening respiratory conditions.

9AE.13

Personal Exposure Using Low Cost PM Sensors in Disproportionately Impacted Denver Communities. MARYAM ANIYA KHALILI, Sumit Sankhyan, Nicholas Clements, Sophie Dolores Castillo, Allison Heckman, Dulce Gonzalezbeltran, Valentina Serrano-salomon, Omar Hammad, Esther Sullivan, Shivakant Mishra, Shelly L. Miller, *University of Colorado Boulder*

The Social Justice and Environmental Quality (SJEQ) – Denver project funded by National Science Foundation (SJEQDenver.com) is working in the communities of Globeville, Elyria-Swansea, Cole, and Clayton to understand and improve the disruption from the major construction going on in the area. Community members used personal low-PM sensors (Atmotubes) to monitor their exposure to air pollution as they went about their day. In total, we engaged with four cohorts of community scientists over the course of two years. We also conducted four colocations with EPA federal reference monitors to develop correction algorithms for the sensors. In each cohort, 50 participants from the communities joined our project and used the Atmotube sensors for an entire month. In the last two cohorts, we provided participants with Do-It-Yourself air cleaners to use during those cohorts.

In this presentation, we will describe our final analysis of these exposure concentration data. Many community scientists had elevated PM2.5 exposure concentrations. Colocation results showed good intra-unit consistency (spearman correlation coefficient rs>0.8), but less agreement with the EPA monitor (spearman correlation coefficient rs>0.5), resulting in a need to correct the final data sets. Trends in exposure concentrations will be explored including distance from major construction, seasonal differences, and weekend/weekday differences. Finally, we will present the results from comparing the cohorts pre and post-intervention looking for trends and information about PM2.5 exposure concentrations within the community.

9AE.14

Coupling of the Weather Research and Forecasting Model with AERMOD for Wildfire-induced Pollution Analysis. YUCHENG HE, Sanika Nishandar, Jiachen Zhang, Marko Princevac, *University of California, Riverside*

Wildfire-induced emissions can cause detrimental impacts on public health. While some regions lack air quality monitoring stations, even for those equipped with monitors, point measurements can be biased representing the air quality in the mesoscale neighborhood due to topographic and meteorological differences. The prediction of air quality through models is a very effective tool for the local authorities to make objective policies for the health benefit of residents. AERMOD is the current EPA-preferred regulatory guideline model for refined permit modeling, which can plot spatial pollution distribution. AERMOD can achieve high prediction accuracy with proper emission inventory and meteorological inputs. To overcome the limitation of lacking hourly meteorological observation data near the source, this study deployed the Weather Research and Forecasting (WRF) Model. WRF is capable of generating onsite past, as well as 384-hour forecasts meteorological inputs for AERMOD. The emission inventory relevant to the fire is estimated by coupling the FINN model, VIIRS satellite detection, and the LANDFIRE database. The WRF-predicted temperature is compared with observation data, while the AERMOD-predicted PM2.5 concentration is compared with measurement data. Both predictions demonstrated satisfactory agreement with the measurement. Such WRF-AERMOD system can predict the pollution distribution near the wildfire incident and assist the local agencies forecast the urban pollution distribution induced by wildfires.

9AE.15

A Data Fusion Model for Rapid Wildfire Smoke PM2.5 Exposure Estimates Using Routinely-available Data. SEAN RAFFUSE, Susan O'Neill, Rebecca Schmidt, *University of California, Davis*

Urban smoke exposure events from large wildfires have become increasingly common in California and throughout the western United States. The ability to study the impacts of high smoke aerosol exposures from these events on the public is limited by the availability of high-quality, spatially-resolved estimates of aerosol concentrations. Methods for assigning aerosol exposure often employ multiple data sets that are time consuming and expensive to create and difficult to reproduce. As these events have gone from occasional to nearly annual in frequency, the need for rapid smoke exposure assessments has increased. The rapidfire R package provides a suite of tools for developing exposure assignments using data sets that are routinely generated and publicly available within a month of the event. Specifically, rapidfire harvests official air quality monitoring, satellite observations, meteorological modeling, operational predictive smoke modeling, and low-cost sensor networks. A machine learning approach is used to fuse the different data sets. Using rapidfire, we produced estimates of ground-level 24-hour average PM2.5 over for large wildfire smoke events in California from 2017-2021. These estimates show excellent agreement with independent measures of PM2.5 from filter-based networks.

9AE.16

Characterization of Metals in Communities at the Fenceline of an Industrial Corridor in Louisiana Using Size-Resolved Filter Measurements and Mobile Monitoring. AMIRA YASSINE, Mina Tehrani, Shivang Agarwal, Edward Fortner, Ellis Robinson, Benjamin Werden, Megan Claflin, Ana Rule, Peter F. DeCarlo, *Johns Hopkins University*

Exposure to metals in aerosol particles emitted from industrial activities can pose serious adverse effects to humans. The St. James, St. John the Baptist, and Ascension Parishes areas in Louisiana, are located 40 miles of South Baton Rouge and are one of the most densely populated industrial corridors in the US. These areas have been under rising scrutiny due to environmental justice concerns. Reported fenceline communities’ exposures in these areas are based on EPA models which feature the facilities' self-reported release data.

During a 4-week sampling campaign in February 2023, metal concentrations in particulate matter were determined in St. James, St. John the Baptist, and Ascension Parishes areas in Louisiana. Two complementary approaches for the determination of 19 metals were used: online measurements of total $PM_{2.5}$ metal concentrations around these areas were conducted using a real-time Cooper x-ray fluorescence (XRF) instrument and fixed site size resolved measurements of metals in PM were conducted using a micro-orifice uniform deposit impactor (MOUDI) filter collection followed by offline analysis using inductively coupled plasma mass spectrometry (ICP-MS).

ICP-MS measurements of size resolved toxic trace elements showed that arsenic, lead, antimony, and vanadium were at the highest concentrations in fine PM with mean concentrations of 0.18, 0.51, 0.26, 0.44 ng/m^3 respectively. Furthermore, the comparison of total concentration of trace elements between the XRF measurements and the MOUDI-ICP-MS measurements showed that a strong agreement exist between the two approaches for vanadium, arsenic, and lead where regression slopes of 0.7, 1.0, 1.0, and high spearman R values: 0.93, 0.90, 0.70, were found for vanadium, arsenic, and lead respectively.

These results suggest that supplementary monitoring of metals in industrial regions continuously and at high time resolution is an important first step towards protecting human health and reducing exposures.

9AE.17

A Mesh-Hopper System for Delivering Microplastic Fibers to Cells at the Air-Liquid Interface for Toxicity Assessment.

Sripriya Nannu Shankar, Amber O'Connor, AMIN SHIRKHANI, Anna Lewis, Alex Theodore, Lee Ferguson, Tara Sabo-Attwood, Chang-Yu Wu, *University of Florida*

Inhalation of microplastic fibers (MPFs) has been reported to cause respiratory lesions, chronic bronchitis, pulmonary fibrosis, lung cancer and chronic obstructive pulmonary disease. Existing *in vitro* exposure systems assessing the toxicity of MPFs rely on suspending the fibers within the medium prior to cell exposures, which is not physiologically relevant. To our knowledge, there is no system that can deliver the fibers directly to cells cultured at the air-liquid interface (ALI). In this study, a custom designed mesh system comprising of a hollow rod (6 mm×50 mm) mounted on a support was developed for the delivery of dyed (19.5 µm×<3 mm) and undyed (14 µm×45 µm) polyethylene terephthalate MPFs. Based on ImageJ analysis of the fibers, the number of fibers/mg of the material were 2,900±824 and 9,010±289 for the dyed and undyed fibers, respectively. Through gravimetric analysis, efficiencies of at least 85% were achieved through the mesh-hopper system, for delivering ~250-2500 and 500-2500 of dyed and undyed fibers respectively, corresponding to doses of 261.2-2612 µg/cm^2 and 168.18-839.39 µg/cm^2. A 6-day repeated dosing of 500 fibers to primary normal human bronchial epithelial (NHBE) cells cultured at the ALI resulted in a cell viability of ~73% for the dyed and ~90% for the undyed fibers, as assessed by trypan blue assay. The cell viability when exposed to the leachate was ~84% and ~98% for the dyed, and undyed fibers, respectively. This suggests that both MPFs and components that leach from MPFs may negatively impact cells *in vitro*, specifically for dyed MPFs that are colored with azobenzene disperse dyes. The study demonstrates the applicability of the mesh-hopper system as a simple, straightforward, and efficient tool to deliver MPFs directly to cells at the ALI, to study the impacts of MPFs on lung cells under *in vitro* conditions.

9AE.18

Assessing Ambient Air Quality Response to Cookstove Intervention.

KY TANNER, John Volckens, *Colorado State University*

In 2019, ambient particulate matter pollution and household air pollution from solid fuels were ranked the 6th and 9th leading risk factors for premature deaths worldwide with 4.1 and 2.3 million estimated annual deaths respectively. Many modeling studies attempt to quantify this risk that exposure to $PM_{2.5}$ from biomass burning for cooking has on premature death globally; however, estimates range widely from 370,000 to 770,000 deaths annually. This is likely because no robust field campaigns have been conducted to date providing empirical evidence validating these models' assumptions. Specifically, the impact switching from biomass to a cleaner burning fuel has on ambient $PM_{2.5}$ concentrations locally. Therefore, this research aims to collect experimental data under real-world conditions that illustrate how a clean cookstove intervention using liquefied petroleum gas (LPG) changes the concentration of ambient $PM_{2.5}$ (particulate matter smaller than 2.5 µm in aerodynamic diameter) over the course of the intervention. Four outdoor air quality samplers were spread throughout a rural village at both central and fence-line locations in Eastern Rwanda (where residents originally cooked exclusively with biomass for fuel). These samplers have collected 5-day samples of ambient air on Teflon filters and recording real-time PM2.5 concentrations each week since November 2022. They have begun monitoring the village's transition from pure biomass burning to a growing percentage of LPG since the start of the intervention in February 2023. Preliminary data suggests a clear spike in $PM_{2.5}$ during the dinner hours with concentrations increasing on average from around 25µg/m^3 to around 70 µg/m^3. However, since less than 20% of the homes in the village have fully adopted LPG for daily cooking tasks it is still unclear if there is a significant decrease in ambient $PM_{2.5}$ concentrations throughout the village as a direct result of the intervention.

9AE.19

Analysis of PM2.5 Inorganic and Organic Constituents to Resolve Contributing Sources in Seoul, South Korea and Beijing, China and Their Possible Associations With Cytokine Il-8. JIEUN PARK, Kyoung-Hee Lee, Hyewon Kim, Jisu Woo, Jongbae Heo, Kwon Ho Jeon, Chang-Hoon Lee, Chul-Gyu Yoo, Philip K. Hopke, Petros Koutrakis, Seung-Muk Yi, *Harvard T.H. Chan School of Public Health*

The most polluted countries in East Asia, namely South Korea and China, have large populations. As neighboring countries, collaborative management plans to maximize public health in both countries can be helpful in reducing transboundary air pollution. To support such planning, $PM_{2.5}$ inorganic and organic species were determined in simultaneously collected $PM_{2.5}$ integrated filters. The resulting data were used as inputs to positive matrix factorization, which identified nine sources at the ambient air monitoring sites in both sites. Secondary nitrate, secondary sulfate/oil combustion, soil, mobile, incinerator, biomass burning, and secondary organic carbon (SOC) were found to be sources at both sampling sites. Industry I and II were only identified in Seoul, whereas combustion and road dust sources were only identified in Beijing. A subset of samples was selected for exposure assessment. The expression levels of IL-8 were significantly higher in Beijing (167.7 pg/mL) than in Seoul (72.7 pg/mL). The associations between the $PM_{2.5}$ chemical constituents and its contributing sources with $PM_{2.5}$-induced inflammatory cytokine (interleukin-8, IL-8) levels in human bronchial epithelial cells were investigated. For Seoul, the soil followed by the secondary nitrate and the biomass burning showed increase with IL-8 production. However, for the Beijing, the secondary nitrate exhibited the highest association with IL-8 production and SOC and biomass burning showed modest increase with IL-8. As one of the highest contributing sources in both cities, secondary nitrate showed an association with IL-8 production. The biomass burning at both locations contained PAHs such as chrysene and indeno[1,2,3-cd]pyrene that are probable human carcinogens and showed modest association with IL-8 production. The soil source having the strongest association with IL-8 production was found only for Seoul, whereas SOC showed a modest association only for Beijing. This study can provide the scientific basis for identifying the sources to be prioritized for control to provide effective mitigation of particulate air pollution in each city and thereby improve public health.

9AE.20

Analyzing Particle Size Distribution of Over-the-Counter (OTC) Topical Spray Drug Products to Inform Inhalation Exposure Risk Assessments. LUCY NANDY, Xiaofei Liu, Robert Bahde, *U.S. Food and Drug Administration*

Some of the aerosol particles produced by over-the-counter (OTC) topical spray drug products under standard usage have the potential to penetrate deeply into the lungs after being inhaled. Respirable particles may cause inhalation toxicity depending on their chemical properties as well as their dosage. This study evaluated the particle size distribution of such topical spray products after they were actuated from their spray can. Laser diffraction (LD) was used to measure particle size distribution, and therefore, assess the potential inhalation exposure from drug products that become airborne under typical usage. 19 sunscreen spray products were studied for which the average aerosol delivery rate was ~1 g/s, as measured. It was found that less than 5% of the particle mass concentration consisted of particles smaller than 10 µm. However, the measurements did not consider the reduction in particle size after evaporation or breakage of bigger droplets into smaller ones. For a better evaluation, the mass concentration of respirable particles was evaluated with respect to time in a typical indoor environment using an evaporation model. It was found that for particles with an aerodynamic diameter less than 10 µm, the particle mass concentration increased and remained suspended in the air for up to an hour with no ventilation. The result was based on evaluating particles of diameter less than 40 µm assuming non-evaporative chemical composition to be a typical 24 – 28% by mass (weight percent of chemical UV filters/active ingredients in the test sunscreen products), negligible volatile components, and stationary state evaporation process of water. Further work is needed to evaluate potential inhalation dosage of fine particles that remain post evaporation after one typical usage of the product. Such data may help inform future requirements aimed at limiting unintended inhalation exposure from spray drug products.

9AE.21

Fast Prediction of Comprehensive Human Infection Risk Using Computational Fluid Dynamics and Machine Learning.

HYEONJUN LEE, Donghyun Rim, *Pennsylvania State University*

Previous studies performed Computational Fluid Dynamics (CFD) to examine local infection risk within occupied spaces. Although these studies provided valuable insights, it has been challenging to predict the infection risks considering all possible cases such as building operating conditions, student density, number of infectors and location, and the airflow pattern, resulting in increased computational time and cost. This study presents a framework to assess infection risk in a learning environment using CFD and Artificial Intelligence (AI). The objectives of the study are to (1) predict comprehensive risk assessments with multiple parameters by creating an AI model based on CFD results; (2) evaluate the effect of occupant configuration on infection risk.

The study investigates a classroom with seven occupants by varying parameters, including ventilation modes, air change rates, occupant arrangements source locations, source strengths, and particle sizes. A total of 448 scenarios will be trained using an Artificial Neural Network (ANN) and Long Short-Term Memory (LSTM) model to predict infection risk.

The results reveal that a space with displacement ventilation at a minimum ventilation rate require a number of inhalable 10 µm particles twice as mixing ventilation, and four times for 1 µm particles. It is also shown that, for both ventilation strategies beyond a certain ventilation rate, the number of inhalable particles increased for occupants in a back row implying that increasing the ventilation rate does not necessarily guarantee preventing spread of infectious particles. Based on the results generated by CFD, the AI model could predict the particle emitted number with less than 10% of error. The results can be used to inform HVAC system design and operation strategies to reduce the risk of infection in indoor environments.

9CC.2

Physical and Chemical Properties of Aerosol Particles in the Rural Area Near Houston, Texas. JING LI, Jiaoshi Zhang, Xianda Gong, Steven Spielman, Chongai Kuang, Ashish Singh, Maria Zawadowicz, Lu Xu, Jian Wang, *Washington University in St. Louis*

Convective clouds play a critical role in the Earth’s climate system. While theoretical and modeling studies have shown that aerosols could have a strong impact on convection, robust observational quantification of an aerosol effect on convective clouds remains elusive. The Tracking Aerosol Convection Interactions ExpeRiment (TRACER) campaign took place in the greater Houston area from 2021 to 2022, with the main objective of providing observations of convective clouds over a broad range of aerosol regimes. Here we present a comprehensive analysis of aerosol measurements conducted at a rural site southwest of Houston from June to September 2022 during the intensive observation period of the TRACER campaign. Based on the air mass back-trajectories, air masses arriving at the site were classified into three types, including (1) dominated by marine aerosols from the gulf, (2) strongly influenced by urban (i.e., Houston) emissions, and (3) mixtures of marine and continental aerosols. Among the three types, marine aerosols have the lowest number concentration (0.65 to 7.17 × 10^3 cm^{-3}) and PM_1 mass (1.28 to 9.04 µg m^{-3}), and they exhibit a bimodal size distribution. In comparison, air masses strongly influenced by urban emission show a unimodal aerosol size distribution and the highest number and PM_1 mass concentrations, 1.51 to 18.27 × 10^3 cm^{-3} and 2.09 to 18.98 µg m^{-3}, respectively. For marine aerosols, sulfate represents the largest component of PM_1 mass (41%), while organics dominate the composition of aerosols strongly influenced by urban emissions. This is consistent with the observed higher hygroscopicity of marine aerosols. In all air mass types, elevated nucleation mode aerosol concentrations were observed around noon time, followed by particle growth, indicating new particle formation. Positive matrix factorization (PMF) analysis of aerosol mass spectrometry data was carried out to identify organic components. The major aerosol sources and their influences on aerosol size distribution, composition, and cloud condensation nuclei (CCN) concentration are discussed.

9CC.3

Investigating the Vertical Variability of Aerosol Composition, Morphology and Mixing State over Crested Butte Mountain: Impacts on Ice Nucleation. NURUN NAHAR LATA, Jessie Creamean, Thomas C. J. Hill, Russell Perkins, Sonia Kreidenweis, Zezhen Cheng, Darielle Dexheimer, Alexander Laskin, Paul DeMott, Daniel Feldman, Swarup China, *Pacific Northwest National Lab*

Aerosol particles in the atmosphere can serve as ice nucleating particles (INPs) and initiate ice crystal formation, leading to cloud formation and precipitation. The composition and mixing state of aerosol particles can affect their ice nucleation (IN) potential, making it essential to understand their vertical variability. This study investigated the vertical variability of aerosol particle composition and its relationship to INP characteristics. The aerosol particles were sampled during July 2022 using a Size and Time-resolved Aerosol Collector (STAC) platform and an “IcePuck” filter sampler deployed with tethered balloon system (TBS) at the US Department of Energy's Atmospheric Radiation Measurement Program's primary site at Crested Butte Mountain at an elevation of 2886 meters during the Surface Atmosphere Integrated Field Laboratory (SAIL) study for offline chemical and IN analysis, respectively. Filter samples are being used to probe the freezing properties of the particles using the CSU Ice Spectrometer, emphasizing immersion freezing in the 0 to -30°C regime. The STAC collected particles were characterized by using multimodal micro-spectroscopy techniques such as computer-controlled scanning electron microscopy (CC-SEM) with energy-dispersive X-ray spectroscopy and scanning transmission X-ray microscopy with near-edge X-ray absorption fine structure spectroscopy for their chemical composition, size distribution, and mixing state. The chemical analysis shows a variation of size-resolved chemical composition and mixing state across altitudes at the times of pre-convection and light precipitation. The dominant particle classes include carbonaceous, sulfate with minor dust, and potassium-rich particles. A custom-built IN cell, interfaced with an environmental SEM will also be used to probe the IN potential of the collected particles at a single particle level, emphasizing deposition nucleation in -40 to -60°C temperature regime and to characterize the residuals after IN. Once combined, these results will help to refine climate models and predictions of cloud formation and precipitation patterns in response to environmental changes.

9CC.4

New Insights into Aerosol Roles in the Earth System with UAS Observational Capability. FAN MEI, Hailong Wang, Zihua Zhu, Damao Zhang, Qi Zhang, Jerome Fast, William Gustafson, Xiangyu Li, Beat Schmid, Christopher Niedek, Jason Tomlinson, Connor Flynn, *Pacific Northwest National Laboratory*

The spatial distribution of ambient aerosol particles plays a crucial role in aerosol-radiation and aerosol-cloud interactions, contributing significantly to the largest uncertainty in global anthropogenic radiative forcing estimations. Unfortunately, the boundary layer and lower free troposphere have not been adequately sampled with a sufficient temporal and spatial resolution to fully understand various atmospheric processes, which hampers our ability to comprehend the Earth system better. Thankfully, the development of uncrewed aerial systems (UAS) coupled with advanced measurement techniques provides much-needed mesoscale spatiotemporal data of the aerosol microphysical and optical properties around the Southern Great Plains (SGP observatory). We have used a state-of-the-art 3-dimensional molecular imaging technique enabled by secondary ion mass spectrometry and nanogram-level chemical composition analysis capability via micronebulization aerosol mass spectrometry to identify the dominant role of the organic-enriched nanometer layers at the surface of aerosol particles in determining aerosol optical and hygroscopic properties profiles above the SGP observatory. Overall, this study highlights the potential of UAS coupled with advanced measurement techniques to improve our understanding of the aerosol life cycle and provide valuable data needed to enhance and optimize sampling strategies.

9CC.5

Black Carbon Aerosols and Aerosol-Cloud Interactions over the Northeastern Pacific Ocean. DONGLI WANG, Bradley Ries, Minghao Han, Alexander B. MacDonald, Don Collins, Roya Bahreini, Patrick Chuang, Lisa Welp-Smith, Mikael Witte, Andrew Metcalf, *Clemson University*

Black carbon (BC) aerosol is a potentially significant contributor to aerosol-cloud interactions. BC aerosol is highly absorbing and thus potentially exerts important influence on cloud microphysical and radiative properties. The northeastern Pacific Ocean, off the coast of Southern California (CA), is a natural laboratory where aerosols originating from the San Diego to Los Angeles corridor interact with persistent stratocumulus. This talk will characterize the nature of BC aerosols over this region and investigate the interactions between BC particles and the marine atmosphere, including the persistent cloud cover.

A suite of aerosol and cloud instruments onboard the Navy Twin Otter aircraft made observations near San Diego, CA in June 2023 as part of the SCILLA field campaign in coordination with the EPCAPE campaign. A Single Particle Soot Photometer (SP2) is employed as the primary measurement of BC aerosol, including its size and mixing state. A scanning mobility particle sizer (SMPS) is used to measure the total submicron aerosol size distributions. Other aerosol instrumentation is used to characterize composition and cloud condensation nuclei, and several instruments were toggled between an isokinetic inlet and counterflow virtual impactor (CVI) inlet. Various cloud probes characterize the cloud droplet number concentrations and size distributions. With these data, the impact of BC aerosol and its mixing state on aerosol-cloud interactions in the marine boundary layer and free troposphere can be investigated. Results from this study are compared to a prior field campaign conducted in the summer of 2018 near the Monterey Bay area. Detailed characterization and investigation will help to understand the connection between BC aerosol and cloud properties to evaluate their impact on the marine environment.

9CC.6

Characterization of Submicron Aerosol Composition and Hygroscopicity in Houston, TX during TRacking Aerosol Convection Interactions ExpeRiment (TRACER) Campaign. MARIA ZAWADOWICZ, Chongai Kuang, Ashish Singh, Janek Uin, Tamanna Subba, Dié Wang, Rebecca Trojanowski, Arthur J. Sedlacek, Olga Mayol-Bracero, Michael Jensen, *Brookhaven National Laboratory*

The TRacking Aerosol Convection interactions ExpeRiment (TRACER) campaign took place in the Houston, TX region from October 2021 through September 2022, with the objective of providing new measurements for the study of interactions between aerosols and deep convective clouds. The Atmospheric Radiation Measurement (ARM) Mobile Facility, deployed in the often heavily polluted location of La Porte, TX, provided a comprehensive suite of surface-based in situ and remote sensing measurements of cloud and aerosol properties, precipitation, meteorology and solar radiation. This presentation will focus on describing the seasonal characteristics of boundary layer aerosol sampled during the TRACER campaign, especially its non-refractory composition, size distributions and hygroscopicity. We compare several ways of carrying out aerosol source apportionment to disentangle different airmass characteristics and events of interest in the coastal urban atmosphere. We find that the hygroscopicity of the boundary layer aerosol sampled at TRACER is modulated by airmass origin: aerosols originating or transported over the Gulf of Mexico are more hygroscopic than the organic-dominated urban pollution.

9CC.7

Study Design and First Results of the 2023 Soot-on-Snow Campaign. HANS MOOSMÜLLER, Jonas Svensson, Krista Luoma, Delun Li, Outi Meinander, Anna Kontu, Olli Sippula, Oona Norvapalo, Janne Jänis, Pavla Dagsson-Waldhauserová, Aki Virkkula, *Desert Research Institute*

Five Soot-on-Snow (SoS) experiments have been organized by the Finnish Meteorological Institute (FMI) since 2011 to study effects of soot deposition on snow optics and melting. Since 2013, SoS experiments were conducted at an abandoned airfield near FMI's Sodankylä observatory in Lapland. In all experiments, soot particles are blown into chambers standing on top of the snow. After deposition, chambers are removed, and snow samples are taken from contaminated and reference snow spots and are analysed for elemental and organic carbon. The albedo of the snowpack is monitored over deposited and reference areas until snow melts out.

For the 2023 SoS experiments, directed by Virkkula, biomass-burning soot from burning real wood and peat and diesel soot from a diesel generator were used. The smoke is diluted and cooled down in large aluminium pipes covered with snow and finally injected into a chamber above the snow. Soot samples are taken both from the air blown into the chamber and from the snow after the deposition. These samples are analysed for UV-NIR absorption spectra of water-soluble organic carbon, methanol-soluble organic carbon, and elemental carbon to obtain the contribution of black and brown carbon to melting. Electron microscopy is utilized to study soot particles' structural changes from fractal to more compact forms and chemical composition is analysed using mass spectrometry. Snow samples are taken several times a week after the initial deposition to observe aging. Snow physics measurements include spectral albedo, reflectance and transmittance spectra, snow grain size and type, density, and temperature.

This work was supported in part by the Academy of Finland project "Black and Brown Carbon in the Atmosphere and the Cryosphere" (No. 341271) and by the Broad Agency Announcement Program and the Cold Regions Research and Engineering Laboratory (ERDC-CRREL) under Contract No. W913E523C0002.

9CC.8

The Results of SAIL-Net: Investigating Spatial Variability of Aerosol and Cloud Nuclei in Mountainous Terrain. LEAH GIBSON, Ethan Emerson, Nicholas Good, Anna Hodshire, Ezra Levin, Gavin McMeeking, Kate Patterson, Bryan Rainwater, Tom Ramin, Benjamin Swanson, *Handix Scientific*

In the Western United States and similar regions around the word, precipitation in the mountains plays a crucial role in local and downstream freshwater supplies. Atmospheric aerosols can significantly affect clouds and precipitation by acting as cloud condensation nuclei (CCN) and ice nucleating particles (INP). Gaining knowledge about the variability of atmospheric aerosols in mountainous areas provides valuable information for precipitation forecasting and understanding the impacts of aerosols on the hydrologic cycle. In fall of 2021, we deployed a novel network of miniaturized instrumentation in the East River Watershed near Crested Butte, Colorado, U.S. to contribute to the U.S. Department of Energy (DOE)-funded Surface Atmosphere Integrated Field Laboratory (SAIL). The goal was to better understand aerosol-cloud interactions in mountainous regions. SAIL had two measurement sites in this region, an ARM Mobile Facility (AMF2) and the Aerosol Observing System (AOS). In such complex topography, these two measurement sites could miss important regions of aerosol-cloud interactions. To expand the spread of SAIL measurements, we deployed SAIL-Net, a network of six aerosol measurement nodes spanning both the horizontal and vertical domain of the SAIL region. Each measurement node included a small particle counter (POPS) which counts particle number and sizes them between 140 nm - 2 um; a miniature cloud condensation nuclei counter (CloudPuck); and a filter sampler (IcePuck) for INP analysis. This project aimed to study three, interconnected topics: the spatial variability of aerosols, the temporal trends of aerosols, and the usefulness of dense networks in complex terrain to measure aerosol-cloud interactions. After the project's completion in June 2023, we used the data to explore these areas and improve our understanding of aerosol variability in mountainous areas. We discuss the major insights from our data and analyze the utility of a dense measurement network in this region.

9CC.9

The Analysis of Four Factors for Hygroscopicity Parameterization - Surface Activity, Solubility, LLPS and O/C.

NAHIN FERDOUSI, Kanishk Gohil, Kotiba A. Malek, Dewansh Rastogi, Kiran R. Pitta, Qishen Huang, Miriam Freedman, Akua Asa-Awuku, *University of Maryland, College Park*

Aerosols and aqueous droplets can be composed of both inorganic salts and organic compounds; the composition impacts the droplet's water uptake capability, also known as hygroscopicity. Prior studies focusing on internal binary mixtures focus on the influence of factors, such as oxygen to carbon (O/C) ratio, solubility, and liquid-liquid phase separation (LLPS) on hygroscopicity. Within these models, it is assumed that the surface tension of the droplet is equivalent to the surface tension of pure water. However, few studies have collectively discussed the presence of surface-active compounds, LLPS, solubility, and O/C influencing water-uptake (hygroscopicity).

In this study, we investigated the hygroscopicity of inorganic salt, ammonium sulfate (AS) and organic, surface-active compound, 2-methylglutaric acid (2-MGA), mixtures. AS/2-MGA compositions were varied by weight percentage in solution and then atomized. Hygroscopicity at subsaturated conditions was determined using a hygroscopicity tandem differential mobility analyzer (H-TDMA) and kept constant at a relative humidity of 89% ± 1.5%. Hygroscopicity was measured at supersaturated conditions using a cloud condensation nuclei counter (CCNC), at 0.4 to 1% SS. Measurements determined the single hygroscopicity parameter, κ, for each mixture. Mixtures predominantly composed of AS, up to a 1:1 AS/2-MGA composition, exhibit κ values close to pure AS at 0.57 ± 0.03. However, as the aerosol composition transitioned to being predominantly composed of the surface-active compound, hygroscopicity decreased significantly. Furthermore, as the composition of 2-MGA increases, a larger discrepancy between sub- and supersaturated estimated κ was observed. Hygroscopicity models utilizing variations of modified Köhler theory show that accounting for bulk surface tension presents a significant improvement in the agreement of measurement and prediction. Cryo-TEM droplet images demonstrate phase separation behavior and support the previous observations. Thus, the mixed inorganic/ organic surfactant composition is best described with uptake models that account for both liquid-liquid phase separation and surface tension depression. The findings of this study can help further enhance our understanding of cloud-forming properties of complex chemical mixtures containing surface-active organic and inorganic compounds. This work shows that accounting for surface tension partitioning via O/C can improve water uptake and CCN prediction of aerosol mixture.

9CC.10

Impact of Aerosol on Precipitation in Stratocumulus Clouds: Insights from Long-Term Measurements in the Eastern North Atlantic.

MAIQI ZHANG, Shengqian Zhou, Virendra Ghate, Maria Cadeddu, Christine Chiu, Jian Wang, *Washington University in St. Louis*

Aerosols can strongly influence climate by modifying the properties of clouds. An increase in cloud condensation nuclei (CCN) concentration can reduce cloud droplet size, and thus lower coalescence efficiency among smaller cloud droplets, leading to precipitation suppression and enhanced cloudiness. However, quantifying this precipitation suppression effect is challenging because of the confounding effects of meteorological and thermodynamic factors. Additionally, the size of CCN is critical to precipitation formation. In particular, giant cloud condensation nuclei (GCCN) can instead promote the formation of large drops and expedite precipitation formation, but their impact on precipitation has not been quantified using long-term observations.

To isolate the impact of aerosol on precipitation, we employed precipitation rate susceptibility (S_R) as a metric, which quantifies the variation of precipitation with changes in CCN concentration under fixed cloud liquid water path (LWP). Earlier studies of S_R were mostly based on short-term measurements, and very few of them examined the impact of GCCN. In this study, we analyzed over 6 years measurements of CCN, cloud, and precipitation from the Graciosa Island in the Eastern North Atlantic to investigate how the S_R varies with LWP, and how it compares with previous studies. We will discuss how these variations in the trend of S_R -LWP are attributed to the transition from autoconversion to accretion in precipitation formation. Using supermicron aerosol scattering coefficient as a proxy for GCCN concentration, we found that higher GCCN concentrations reduce the sensitivity of precipitation to aerosol perturbations (i.e., lower S_R value) by "short-circuiting" the coalescence bottleneck and formation of drizzle embryos. By controlling the CCN concentration and LWP, we showed that higher GCCN concentrations promote precipitation rates. These results provide new insights into the complex relationship between aerosols, clouds, and precipitation, contributing to our understanding of the aerosol effects on clouds.

9CC.11

Investigation of Secondary Aerosol Formation Potential of Air off the Coast of Southern California. MINGHAO HAN, Bradley Ries, Alexander B. MacDonald, Roya Bahreini, Don Collins, *University of California Riverside*

The area of the Pacific Ocean within the California Bight that extends from Point Conception in California to Punta Colonet in Baja California is notable for its substantial and enduring stratocumulus cloud layer. Polluted air from Los Angeles/Long Beach (LA/LB) can be drawn offshore and interact with the cloud layer over the Bight. Prevailing winds typical in late spring and early summer, commonly carry pollution from LA/LB to the south and towards the San Diego area. This area is ideal for studying aerosol-cloud interactions (ACI) between marine stratocumulus and a mixture of pollution and natural aerosol spinning a wide range in concentration. Since early 2023, the chemical and radiative properties of the aerosol in La Jolla, CA have been characterized as part of the DOE Eastern Pacific Cloud Aerosol Precipitation Experiment (EPCAPE). To complement and leverage EPCAPE, the Naval Postgraduate School Twin Otter research aircraft was deployed during the June 2023 Southern California Interactions of Low Cloud and Land Aerosol (SCILLA) experiment. The flights provided a regional context for the point measurements in La Jolla and captured the spatial variability relevant to models. The analysis presented here uses a subset of the measurements from SCILLA with a focus on those from an oxidation flow reactor (OFR), that was specifically designed and constructed to comply with aircraft physical and sampling constraints. We describe secondary aerosol formation potential of air influenced to varying extent by LA/LB emissions and to varying extent by gas- and cloud-processing over the Bight. These measurements provide valuable insights into the relationship between cloud properties and the temporally and spatially variable aerosol field between LA and SD.

9CC.12

The Application of a Generalized Hygroscopicity Parameterization for Climate Modeling. Kanishk Gohil, Andrew Gettelman, AKUA ASA-AWUKU, *University of Maryland*

The indirect effect of aerosols on clouds, including that due to organic aerosols, is a significant source of uncertainties in climate modeling. One of the uncertainties in understanding aerosol-cloud interaction is a systematic misrepresentation of the water uptake behavior (hygroscopicity) of dust and carbonaceous aerosols – including primary organic matter (POM), secondary organic aerosols (SOAs), and black carbon (BC). The hygroscopicity of aerosol species in large-scale models, such as the Community Atmosphere Model (CAM), is prescribed based on the traditional Köhler theory (KT). Since KT assumes aerosols to be infinitely soluble in water, KT-based hygroscopicities are regularly found to have uncertainties for several organic aerosols that have low water solubility. These uncertainties can then translate into the predicted aerosol-cloud interactions. In this work, we implemented the hygroscopicity parameterization based on the novel Hybrid Activity Model (HAM) within CAM6. The HAM framework explicitly treats the water solubility of any given compound coupled with adsorption-based droplet growth to predict the Cloud Condensation Nuclei (CCN) activity. Recently, CCN activity analysis using HAM for laboratory measurements indicated that solubility-partitioned, water adsorption-based hygroscopicity may be an improved representation of the water uptake by effectively water-insoluble species. The complex HAM hygroscopicity is represented as a function of particle size by simplification into a power law for implementation within CAM6. We investigate the changes in CCN and droplet properties from HAM-based hygroscopicity parameterization using sensitivity tests as well as full 3D climate simulations. This work is the first to provide a computationally efficient treatment of size-dependent aerosol hygroscopicity for cloud droplet formation for climate modeling. The results suggest that accounting for complex aerosol chemistry for hygroscopicity parameterization can improve estimates of the physical and radiative properties of aerosols and clouds. Similar extensive hygroscopicity treatment of atmospherically relevant aerosols can be considered in other global and regional climate models.

9CC.13

Chemical Characterization of Water-Soluble Organic Gases from Combustion of African Biomass in Cloud Water Mimics as Precursors to Secondary Organic Aerosol. CADE CHRISTENSEN, Vaios Moschos, Megan Mouton, MarkieSha James, Marc Fiddler, Solomon Bililign, Barbara Turpin, Jason Surratt, *University of North Carolina at Chapel Hill*

Wildfire biomass burning (BB) occurrences have been on the rise because of climate change in recent years. BB originating from the African continent has been grossly understudied despite estimates of nearly 50% of all organic carbon emissions being attributed to Africa. Gaseous emissions from BB have the potential to partition into cloud water droplets, undergo oxidation chemistry, and lead to formation of secondary organic aerosol (SOA). To better understand the potential of these emissions to form SOA, this study aims to chemically characterize the freshly generated water-soluble gaseous emissions from native sub-Saharan African plants. Mist chambers were used to mimic cloud droplets and collect gaseous emissions by flowing fresh lab-generated BB emissions through a mist and allowing water-soluble gases to partition into the droplets. Emissions generated from ten unique African biomass fuels were collected to determine emission profiles dependent on fuel type, as well as a mixture of fuels was combusted to mimic a wildfire event that is common to the African continent. Reverse-phase liquid chromatography coupled to electrospray ionization high-resolution quadrupole time-of-flight tandem mass spectrometry (RPLC-ESI-HR-QTOF-MS/MS) was used to analyze the collected emissions. Accurate mass obtained from the QTOF allowed for chemical formula identification, while fragmentation analysis provided insights into functional groups present and potential structures for many compounds. These results will help incorporate impacts of African wildfire emissions in our assessment of atmospheric processes and allow for future studies on aqueous oxidation of these emissions leading to potential SOA formation.

9CC.14

Seasonal Differences in New Particle Formation Events in Crested Butte, Colorado during the SAIL Campaign. ANNA KAPP, James Smith, Celia Faiola, Maria Flores, *Univeristy of California, Irvine*

Climate change is intensifying droughts across the globe. Of particular interest is the effect of drought on mountain regions. Mountain rivers are often used for irrigation in areas that receive little rainfall. Reduced precipitation in the mountains has far reaching effects on surrounding regions. Precipitation cannot occur if clouds do not form, and cloud formation is promoted by the presence of cloud condensation nuclei (CCN) in the air. The Surface Atmosphere Integrated Field Laboratory (SAIL), a DOE-funded field campaign in Crested Butte, Colorado, was dedicated to studying how interactions between the earth and the atmosphere affect precipitation in mountain regions. During SAIL, new particle formation (NPF), one of the main sources of CCN, was frequently observed. Strong seasonal trends were observed in the frequency and characteristics of NPF events, which we examine in this study.

Data on NPF events was collected during 1 September 2021 until 15 June 2023 from an Aerosol Chemical Speciation Monitor (ACSM), Scanning Mobility Particle Sizer (SMPS), Cloud Condensation Nuclii (CCN) counter, and Hygroscopicity Tandem Differential Mobility Analyzer (HTDMA). Airmass back trajectories were calculated using Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) and snowmelt data was collected from a nearby Snowpack Telemetry (SNOTEL) site. Before snowmelt, NPF almost exclusively occurred when the wind was from the north. We believe that these events were caused by transport of sulfur compounds from a coal fire power plant located in Northern Colorado. Immediately after snowmelt, there was a one-month period where NPF occurred almost daily. During this time, ACSM data showed that the mass concentration of total organics in aerosols greatly increased. We believe that the regular occurrence of NPF events after snowmelt was driven by increased biogenic emissions due to spring plant growth.

9CC.15

Comparison of Atomizers Intended for Marine Cloud Brightening. MARYAM SHAHRASEBI, Steven Rogak, *University of British Columbia*

Geoengineering has been proposed to mitigate the impacts of climate change while decarbonization efforts are in progress. Geoengineering can be implemented using a solar radiation management technique called Marine Cloud Brightening (MCB). The underlying principle of MCB is to artificially enhance the reflectivity and longevity of the maritime stratocumulus clouds by injecting seawater aerosols into them. As a result, the imposed negative radiative forcing would cool the planet. However, the presence of giant (1-10 microns) cloud condensation nuclei within the seeded size spectrum expedites precipitation, which may break up the cloud layer. This emphasizes the importance of the energy-efficient injection of the right-sized particles (sub-micrometer particles with median of 30-100 nm) into the targeted clouds.

To identify promising atomizers, we calculated the energy consumed per generated sub-micrometer particle for the atomizers described in the literature. Furthermore, using a Scanning Mobility Particle Spectrometer (SMPS), we evaluated candidate atomizers: Ultrasonic nebulizer (Sonair MedPro), TSI 3076 atomizer, Bubble-gas jet atomizer (proposed by Mezhericher et al. 2017), and effervescent atomizer. In addition, the influence of geometry on bubble-gas jet atomization has been studied. Preliminary results demonstrated the energy consumption of both the Ultrasonic nebulizer and TSI 3076 being in the order of 10^{-9} J/particle, while the Bubble-gas jet atomizer appeared to be more energy-intensive by an order of magnitude. However, none of them falls within the range of energy-efficiency needed for MCB which is in the order of 10^{-12} J/particle. Additional results of the effervescent atomizer would be presented.

9CC.16

Liquid-Liquid Phase Separation (LLPS) Can Drive Aerosol Droplet Growth in Supersaturated Regimes. Kotiba A. Malek, Kanishk Gohil, Esther Olonimoyo, Nahin Ferdousi, Qishen Huang, Kiran R. Pitta, Lucy Nandy, Katelyn Voss, Tim Raymond, Dabrina Dutcher, Miriam Freedman, AKUA ASA-AWUKU, *University of Maryland, College Park*

The atmospheric aerosol composition is typically a mixture and consists of a wide range of organic and inorganic particles that interact with each other. Furthermore, water-vapor is ubiquitous in the atmosphere and the presence of water can alter the aerosol morphology and propensity to form droplets. Specifically, aerosol mixtures can undergo liquid-liquid phase separation (LLPS) in the presence of water-vapor. However, the experimental conditions for which LLPS impacts water uptake and the subsequent prediction of aerosol mixtures is poorly understood. To improve our understanding of aerosol mixtures and droplets, this study explores two ternary systems that undergo LLPS, namely the 2MGA system (sucrose + ammonium sulfate + 2-methylglutaric acid) and the PEG1000 system (sucrose + ammonium sulfate + polyethylene glycol 1000). In this study, the ratio of species and the O:C ratios are systematically changed, and the hygroscopic properties of the resultant aerosol were investigated. Here we show that the droplet activation above 100% RH of the 2MGA system was influenced by LLPS, while the droplet activation of the PEG1000 system was observed to be linearly additive regardless of chemical composition, O:C ratio, and LLPS. A theoretical model that accounts for LLPS with O:C ratios was developed and predicts the water uptake of internally mixed systems of different compositions and phase states. Hence, this study provides a computationally efficient algorithm to account for the LLPS, and solubility parameterized by the O:C ratio for droplet activation at supersaturated relative humidity conditions and may thus be extended to mixed inorganic-organic aerosol populations with unspeciated organic composition found in the ambient environment.

9CC.17

Absorption Enhancement of Atmospheric Black Carbon Driven by Coating Morphology. CYPRIEN JOURDAIN, Yu Wang, David Neubauer, Jonathan Symonds, Ulrike Lohmann, Adam M Boies, *University of Cambridge*

Black carbon (BC) particles are short-lived climate forcers that strongly alter the regional direct radiative forcing (RF) due to the rapid mixing with semi volatile compounds present in the atmosphere. While recent models have highlighted the need to account for soot morphology to reduce the large uncertainties associated with BC RF estimation, studies of the coating evolution - a key element responsible for absorption enhancement - have been limited, especially for non-uniformly coated (NUC) soot agglomerates. In this work, we evaluate the effects of both the intrinsic BC structure and the non-uniform coating of fractal BC agglomerates on the physico-optical properties of coated BC by interfacing the CA^{2}M generation tool with a discrete dipole approximation model (DDSCAT). Realistic parametrizations in term of mass absorption cross-section (MAC) have been found and used in the ECHAM-HAM global model. Significant improvement in the parametrization using the NUC model that shows a small absorption enhancement for low coating fraction, in agreement with several ambient measurements reported in the literature. Above a critical mass ratio threshold (~14), the BC particles become encapsulated in droplets that eventually have a spherical morphology, maximizing the lensing effect. A comparison of MAC with current coated BC models reveals a closer agreement of NUC with the core-shell (CS) Mie theory than with the uniformly-coated BC models found in literature. Comparing these models highlights the need to account for coating morphology, which impacts the BC absorption, significantly more that the BC internal structure itself. Global simulation results show a positive RF induced by BC between the pre-industrial era and the present days, especially in regions of China, India, and some regions of the Arabic Peninsula, Western Africa and South America.

9CC.18

Ice Nucleation By Smectites: The Role of the Clay Mineral Edges. ANAND KUMAR, Kristian Klumpp, Chen Barak, Giora Rytwo, Michael Plötze, Thomas Peter, Claudia Marcolli, *Eidgenössische Technische Hochschule Zürich (ETHZ)*

Smectite clay minerals have been shown to promote ice nucleation in the immersion freezing mode and likely contribute to the population of ice nucleating particles in the atmosphere. Smectites are layered aluminosilicates, forming platelets that might swell or even delaminate in water by intercalation of water molecules between their layers. We investigated the ice nucleation (IN) activity of a variety of natural and synthetic smectites with different exchangeable cations. The montmorillonites STx1b and SAz1, nontronite SWa1 and hectorite SHCa1 are rich in Ca^{2+} as the exchangeable cation. Synthetic Laponite is a pure Na^+ smectite and synthetic mica-montmorillonite Barasym carries ammonium as the exchangeable cation. In emulsion freezing experiments, all samples except Laponite exhibited one or two heterogeneous freezing peaks with onsets between 239 K and 248 K and a large variation in IN activity, yet without clear correlation with exchangeable cation, type of smectite or mineralogical impurities in the samples. Furthermore, replacing with Ca^{2+} in Barasym reduced its IN activity to that of other Ca-rich montmorillonites. Stepwise exchange of the native cations in STx1b with Y^{3+} and Cu^{2+} showed no influence on IN activity. However, aging of smectite suspensions in pure water up to several months revealed a decrease in IN activity, which we attribute to the delamination of smectites in suspensions, which occurs over long timescales. The dependence of IN activity on platelet stacking and thickness can be explained if the hydroxylated chains forming at the edges are the location of IN, since the edges need to be thick enough to host a critical ice embryo. We hypothesize that at least three smectite layers need to be stacked together to host a critical ice embryo on clay mineral edges and that the larger the surface edge area is the higher the freezing temperature.

9CC.19

The Emissions of Intermediate-volatility and Semi-volatile Organic Compounds from Chinese Diesel Vehicles under Different Engine Conditions. XIAO ZHANG, *Tsinghua University*

Intermediate volatility organic compounds (IVOCs) emerge as significant potential SOA contributors in recent works. IVOCs are chemical compounds with effective saturation concentration between 103 and 106 µg/m3, which generally corresponds to the volatility range of C12 -C22 n-alkanes. The smog chamber experiments illustrated that the majority of SOA is contributed by IVOCs aging processes. The IVOCs emitted from diesel vehicles contribute 30% of the total SOA in London. More than 50% SOA produced by mobile sources, which is the largest source contributor of organic aerosol in Southern California, is originated from the oxidation of IVOCs.

Many researches have shown that the I/SVOC chemical composition and volatile distribution of mobile sources depend on the fuel type, engine load, and aftertreatment technology. IVOC emissions are highly dependent on engine power, with highest emissions at engine idle. With the increasing of engine load, engine combustion efficiency is continuously improved, and gaseous and particle I/SVOC emissions are gradually reduced. Compared with idle conditions, the gas-phase I/SVOC emission factors under 100% engine load decreased 72%-76%. At low load operations, the chemical composition of I/SVOC dominated by saturated hydrocarbon species. With engine load increased, IVOC become increasingly characterized by unsaturated hydrocarbons and oxygenated organics. The proportion of aromatic hydrocarbons in IVOCs increased with a higher load. With the increase of engine load, the saturation of gaseous I/SVOC decreases gradually. The proportion of saturated hydrocarbons (alkanes+ cycloalkanes) decreased from 61% to 40%. The proportion of unsaturated substances (olefin + aromatic hydrocarbon +OVOC) increased from 39% to 60%. The proportion of oxygen compound emission increased with the increase of engine load, which is newly formed in the incomplete combustion process when the engine temperature and pressure rise.

We discovered that chemical composition and volatility distribution measured I/SVOC emissions during engine idle operating conditions that were similar to diesel fuel which indicated that gaseous I/SVOC emission at low load is mainly from the direct volatilization of unburned diesel. The compositions of IVOCs were not consistent with diesel fuel under high loads which indicated that different formation pathways of IVOCs exist for different engine loads. At high load, other sources of IVOC will become the main source, which may be the pyrolysis of lubricating oil or diesel oil at high temperature.

9CM.1

Model-guided Control of Nanofiber Orientation in Nanomanufacturing of Next-gen Air Filters. KEVIN K. CROWN, Yury Salkovskiy, Yuris Dzenis, *National Strategic Research Institute*

While no filter medium has shown to be 100% effective, filtration is the primary defense against the inhalation of hazardous biological or chemical particles. Submicron particles pose the largest health risk since they are best able to penetrate filter media and enter deeply into the respiratory tract, increasing the certainty of illness from the exposure. Since the filter media currently used in conventional air purifying respirators (APRs) have a limited wearing time due to high breathing resistance and often have insufficient filtering efficacy, an improved filter medium with high filtration efficacy and low breathing resistance is needed. Randomly woven nanofibers of 100-150 nm diameter have high specific filtration surface area, porosity, and interfiber distances which yield high particulate filtration efficacy, but also have a high pressure drop which makes them difficult to breathe through for any length of time in an APR. We believe that by aligning the nanofibers during the electrospinning process, filtration of the most penetrating particles will be much improved, a decreased pressure drop will be realized, and the aligned nanofibers will impart an increased mechanical strength in the direction of the nanofiber orientation that will increase their durability. After working to develop such an electrospinning method, we have tested filters with better aligned nanofibers for filtration efficiency against aerosolized MS2, a 23-28 nm bacteriophage virus, and aerosolized submicron beads and have shown promising results in filtration when compared to that of commercially available filter media.

9CM.2

Modeling of a Novel Large-scale Electrohydrodynamic Vortex Flow Induced by Variation in Current Density for Drag Reduction.

ERIC MONSU LEE, *Northern Illinois University*

The recent emphasis on environmental justice by the U.S. EPA has motivated the aerosol research community to develop innovative and cost-effective particulate matters (PMs) control technologies for subpopulations who are frequently exposed to indoor PMs. PM collection by electrostatic precipitation (ESP) has been proposed for indoor usage because it provides advantageous features over conventional fabric filters, such as lower energy consumption and being filterless. However, further research is needed before ESP can be used in indoor spaces, as ESP involves corona discharge that generates trace amounts of ozone and the particle collection efficiency for fine and submicrometer particles is highly variable due to a lower rate of particle charging. The ultimate goal for the present study is to address the issue of low collection efficiency for submicrometer particles by using electrostatic particle agglomeration. A novel large-scale electrohydrodynamic (EHD) vortex flow was previously discovered in the streamwise direction of a cylindrical ESP due to variation in current density. The objective of this modeling study is to characterize the large-scale EHD vortex flow for drag reduction and its implications on particle collection. The numerical model developed by COMSOL Multiphysics® solves the large-scale EHD vortex flow by coupling electrostatic physics with RANS k-ε turbulence flow physics, involving three numerical domains. The present study discovered that the large-scale EHD vortex flow can modify the turbulent boundary layer and result in a reduction in viscous drag near the collection electrode that can potentially lead to improved particle collection involving electrostatic particle agglomeration.

9CM.3

HEPA Filtration in Smart Cabin Air Filter Systems for Vehicles.

Jérôme Migaud, CHRISTOPH KRAUTNER, Thomas Siegele, Martin Lehmann, *MANN+HUMMEL GmbH*

Recent studies show: 90% of all airborne particles are ultrafine particles. UFPs are easily inhaled. They can reach the pulmonary alveoli and affect health. Vehicle occupants are confined to only a few cubic meters without any dilution effects. As a result, the air pollution inside a vehicle cabin can be up to five times higher than outside. Therefore, solutions are needed to protect vehicle occupants.

To improve the air quality in the vehicle we have developed the Smart Cabin Air Filter system which includes up to three filters: a prefilter, a HEPA* filter and an HVAC filter. The prefilter removes coarser particles, thus protecting the HEPA (High Efficiency Particulate Air) filter from clogging and maximizing its lifetime. HEPA is designed to remove ultrafine particles from the air and can remove more than 99.95% of those particles. In addition, a particulate sensor controls the PM2.5 concentration in the incoming and outgoing cabin air and actively monitors the filters. Based on the CO2 level in the cabin, a flap controls the incoming air supply. The HEPA filter is activated only when the outside air is extremely polluted, e.g. in a tunnel or traffic jam. The smart control flap system, combined with an algorithm, adjusts and triggers the system's air modes.

We retrofitted an electric car with such a system to prove its benefits. In this scenario, a high-efficiency combi filter with antimicrobial properties and activated carbon for adsorption of odors and harmful gases like SO2, NO2 and VOCs is used as a prefilter. A UV-C device has also been added to neutralize microorganisms. UFPs and PM2.5 filtration efficiency and energy consumption were measured. Thanks to digital solutions, drivers and passengers can monitor the air quality in the cabin.

*Tested according to DIN EN 1822

9CM.4

Characterizing the Long-Term Performance of Four Corsi-Rosenthal Boxes.

GRAHAM JAEGER, Theresa Pistochini, Richard Corsi, Christopher Cappa, *University of California, Davis*

As wildfires intensify and worsen outdoor air quality, securing clean indoor air is more important than ever. Portable air cleaners are one way to improve indoor air quality. The DIY Corsi-Rosenthal Box (CR box), consisting of four MERV-13 filters and a box fan, is a particularly cheap and effective portable air cleaner, and it often out-performs commercially-available HEPA air cleaners. This paper describes the performance of four CR boxes before and after several months of use. We characterize performance by measuring the decay rates of aerosolized particles during air cleaning and calculate the clean air delivery rate (CADR), or the volume of clean air delivered per unit time, for each CR box. Our methodology measures the decay rates of particles ranging from 0.3-3 microns in diameter, so we determine each box's CADR as a function of particle size. Similarly, we report each box's single-pass efficiency, or the percentage of particles removed by the CR box in one pass through the filters. Finally, we take noise, power, and pressure drop measurements for each box to further illustrate their performance. We find that CADR increases with particle size across all fan speeds (low, medium, and high), from about 150 ft3/min for low speed/smaller particles to 650 ft3/min for high speed/larger particles. While the CR boxes' performance after several months of use will be measured prior to the conference, our initial results suggest that CR boxes are effective and affordable air cleaners.

9CM.6

AQ Guard Smart System & MyAtmosphere a Long-term Stable Sensor Network.

VOLKER ZIEGLER, Henrik Hof, *Palas GmbH, Karlsruhe, Germany*

New WHO recommendations (2021) are internationally facing governmental networks with new challenges like extending the network by additional measurement points, lowering the limits for PM10 and PM2.5, request for UFP (Ultrafine Particle) measurements for source appointment on higher spatial and timely resolution.

Sensor networks gain raising importance in high polluted regions where is a lack of measurement infrastructure.

Instrument:
AQ Guard Smart System is a compact and cloud-ready measuring instrument for determination of ambient air quality. In different configurations it provides particulate matter, gas sensors as well as UFP (Ultra Fine Particle) information with number concentration (Cn), Lung Deposit Surface Area (LDSA) and X50 mean diameter. This provides a better understanding about the particle origin.

AQ Guard Smart System is designed for outdoor air measurement in the smart city environment and received MCERTS certification as an Indicative Ambient Particulate Monitor in 2022. The request to be placed on the South Coast AQMD Rule 1466 Pre-Approved Monitor List is already submitted.

Specifications:

- Measurement principles:
    - OPC: Optical light scattering with single particle detection
    - DC: Diffusions Charging
        - Size: 530•270•208 mm (H•W•D); Weight: 6 kg
        - Thermal drying system (IADS compact)
        - Connectivity: USB, Ethernet, Wi-Fi, 3G/4G via Modem, LoRaWAN
        - Field calibration on site possible
        - 12-month service interval
        - No container infrastructure necessary
- Reported data:
    - OPC: PM1, PM2,5, PM4, PM10, TSP, CN, particle size distribution
    - DC: CN, average diameter X50, LDSA (Lung Deposited Surface Area)
- Gas Sensors: SO2, CO, NO2, O3, TVOC, CO2
- Meteo: ambient pressure, ambient temperature, rel. ambient humidity
- Performance / uncertainty:
    - OPC: < 15 % - 20 % for PM
    - Gas: repeatability < 2%; resolution 0.01 ppm; long-term drift < 1% / month

My Atmosphere – the platform:
MyAtmosphere together with AQ Guard Smart System provides a comprehensive cloud based solution to measure, visualize and document air quality in real time. It can be connected to all Palas Systems.

Typical Applications:
Smart City Networks; Natural Risk Areas (volcano eruptions, wildfire, dessert dust events); Construction Sites; Traffic / Road Site Monitoring; Air- & Seaports; Landfills & Open Pit Mining; Industrial Sites; Research Campaigns.

9ES.1

Dynamic Aerosol Characteristics Surrounding Storms Observed in Northern Colorado During the BACS-I and BACS-II Field Campaigns. Russell Perkins, Ben Ascher, Tyler Barbero, Noelle Bryan, Charles Davis, Paul DeMott, Jacob Escobedo, Nick Falk, Janeshta Fernando, Teresa Feldman, Sean Freeman, BRIAN HEFFERNAN, Thomas C. J. Hill, Sonia Kreidenweis, Gabrielle Leung, Chamari Mampage, Allie Mazurek, Claudia Mignani, Daniel Veloso-Aguila, Christine Neumaier, Marina Nieto-Caballero, Lexi Sherman, Susan van den Heever, Leah Grant, Elizabeth Stone, *Colorado State University*

Aerosol particles impact the properties of clouds through their roles as Cloud Condensation Nuclei (CCN) and Ice Nucleating Particles (INPs). CCN allow for the formation of cloud droplets at a critical supersaturation value that depends on particle size and hygroscopicity. CCN that activate at low supersaturations are very rare, but may be important for precipitation initiation and fog formation. INPs allow for freezing of supercooled liquid cloud droplets warmer than their homogeneous freezing temperatures around -38°C. INPs are exceptionally rare, especially at modest supercooling. Biological aerosol particles (bioaerosols) are less abundant than mineral dust aerosol in most terrestrial settings, but can be excellent low-supersaturation CCN and generally dominate populations of warm-temperature INPs. Bioaerosol release can be controlled by environmental conditions, such as rainfall, wind, temperature, and humidity, or combinations of these, such as during a cold pool passage. These mechanisms together create the possibility for feedbacks between bioaerosols and convective cloud systems, where bioaerosol ingestion into clouds alters cloud properties and precipitation.

These bioaerosol-cloud system feedbacks were the focus of the BioAerosols and Convective Storms phase I and II (BACS-I and BACS-II) field campaign which occurred in spring 2022 and 2023 at the USDA-ARS Central Plains Experimental Range (CPER) site in northern Colorado. An extensive suite of aerosol and thermodynamic measurements were employed, collocated with the NSF National Ecological Observing Network (NEON) flux tower at the CPER site. Instrument packages were deployed on the ground, the tower top, and on multirotor drones during each 4-5 week campaign. Measurements include environmental observations, aerosol, bioaerosol, CCN and INP distributions, chemical tracer analysis, airborne DNA sequence analysis, and thermodynamics and dynamics of storm and cold pool passages. This presentation will include an overview of the field campaign and highlight preliminary results of changes to aerosol distributions, populations, and properties with storm passage.

9ES.2

Airborne Algae: Emerging Atmospheric and Health Implications. MICKEY ROGERS, Robert Stanley, *Pacific Northwest National Laboratory*

Microalgae are known to exist in aquatic and airborne environments, but the extent to which microalgae impact atmospheric processes and air qualities is still unknown. Previous work has explored the in situ surface abundance of marine algal blooms by utilizing surface microscopy and spectroscopy techniques (Brewster Angle Microscopy and Sum-Frequency Generation). Over the course of a bloom, algae produce surface-active molecules that temporally partition to the topmost interfacial layers of our oceans. Surface imaging and spectroscopic measurements showed morphological structural changes and heterogeneity in the interfacial film of Skeletonema marinoi at the ocean surface. Interfacial film thickness calculations quantified the average surface thickness of a productive bloom over time, revealing an ~5 nm thick surface region in the late stages of the bloom. Knowing algal species are highly abundant at the water surface and persist in the atmosphere within aerosol means new airborne algal properties need considered. The atmosphere provides rather extreme conditions from the ocean including high acidity (as low as pH 2), high salinity (up to 4 M NaCl), and low temperatures (subzero-20ºC), yet algae are still able to survive. While atmospheric conditions are much different than the ocean, they are proposed to be more favorable for airborne algal cells to exist in aerosol with high surface-area to volume ratios, allowing for greater carbon contacting. Additionally, as warmer waters increase extreme weather events, the concentration of airborne algae and diversity of airborne algal species may increase, presenting new concerns to coastal communities during harmful algal blooms (HABs). Currently, airborne HAB species and toxins are the least-studied organisms in both aerobiological and phycological (the scientific study of algae) studies. New developments in science and policy should prioritize the health impacts of air quality and composition.

9ES.3

Atmospheric Process and Enrichment of Microcystin-LR in Lake Spray Aerosol during Harmful Algae Blooms. BAHARAN EMAM, Myoseon Jang, *University of Florida*

During freshwater harmful algae blooms (HAB), the potential for exposure to aerosolized cyanobacterial algal toxins is not well studied. These toxins represent a range of threats to ecosystem, animal survival, and human health. Over 250 different microcystins have been discovered, of which microcystin-LR(MC-LR) is the most common. Waterborne MC-LR has been widely studied due to its severe hepatotoxicity but the adversity of airborne MC-LR in algal aerosol is poorly investigated. A fundamental question remains over the enrichment of MC-LR in freshwater algal aerosol and its longevity in aerosol. Airborne MC-LR can be enriched in algal aerosol, which is created from the bursting of bubbles at the lake and estuaries' surface. In this study, water and lake-spray aerosol (LSA) are collected in HAB sites in Florida. LSA is collected by using the Particle-Into-Liquid-Sampler (PILS) with the modified method with a minimal use of water. MC-LR in both water and LSA samples is analyzed with the Enzyme-Linked ImmunoSorbent Assay (ELISA). The characterization of water and LSA is performed to identify the quantity of organic matter (OM) and inorganic compositions (sulfate, nitrate, ammonium, sodium, and potassium). ELISA or OM data were normalized with ionic constituents to examine enrichment of MC-LR and OM. The recent chamber study finds the rapid degradation of MC-LR in cyanobacterial aerosol. The simulated MC-LR decay by the kinetic model (i.e., Harmful Algal Aerosol Reaction (HAAR) model) based on chamber study suggests that the lifetime of MC-LR is in the scale of several minutes. The longevity of MC-LR in LSA during HAB is examined by measuring MC-LR as a function of distance from the source and compared with chamber observation. Additionally, the light absorbance of cyanobacterial aerosol is measured in situ with a reflectance micro-UV spectrometer. The change of functional groups in LSA is also analyzed with FTIR data.

9ES.4

Deployment of the DOE 3rd ARM Mobile Facility (AMF3) to the Southeastern United States: A Vision for Integrated Model-Observing System Design for Targeting Land-Aerosol-Cloud Interactions. CHONGAI KUANG, Shawn Serbin, Scott Giangrande, *Brookhaven National Laboratory*

The DOE ARM user facility has relocated the third ARM Mobile Facility (AMF3) to the Southeast United States for a five-year deployment starting in the Fall of 2023, with siting focused on the Bankhead National Forest in Northern Alabama. The Southeast United States is a region characterized by: high vegetative emissions of volatile organic compounds; a wide range in anthropogenic emissions from proximity to rural areas and dense urban cores; biomass burning from periodic prescribed and unplanned burning; and large amounts of secondary organic aerosol. This AMF3 deployment is a unique opportunity to improve understanding and model representation of coupled aerosol, cloud, and land-surface processes in an environment where such processes are strongly driven by local forcings. A defining aspect of this AMF3 deployment is an expectation for long-term (5 year) observations to account for seasonal to annual variability. Understanding the role of spatiotemporal variability (e.g., atmospheric thermodynamic variability, variation in land-surface properties and seasonality) across aspects of the climate system is a key motivator for AMF3 studies. This is especially true for characterizing the relationships between aerosol and land-surface processes over a diverse patchwork of natural, managed, and urban landscapes found across the region. The AMF3 site science team will present updates on facility siting, configuration, instrumentation, and sampling strategies in support of the coupled aerosol, cloud, and land-atmosphere interactions science drivers.

9ES.5

Observationally Constrained Modeling of the Reactive Uptake of IEPOX under Elevated RH and Varying Acidity of Seed Aerosol Conditions. JIE ZHANG, ManishKumar Shrivastava, Alla Zelenyuk, Rahul Zaveri, Jason Surratt, Matthieu Riva, David Bell, Marianne Glasius, *Pacific Northwest National Laboratory*

Isoprene is the non-methane volatile organic compound (VOC) emitted in the largest amounts to the atmosphere, and it is a significant source of secondary organic aerosol (SOA) mass. The uptake of isoprene oxidation products followed by multiphase chemistry in fine particles is the key pathway to form isoprene epoxydiol-derived SOA (IEPOX-SOA). However, many parameters that relate to the diffusion and reaction of IEPOX in the particle phase remain uncertain, since reaction kinetics previously measured in bulk aqueous phase solutions might be different from atmospheric aerosols. Here, we use simultaneous environmental chamber measurements of multiple parameters governing IEPOX-SOA formation at timescales of ~hours: particle size distribution, composition, and volatility of IEPOX-SOA to constrain the key parameters governing IEPOX-SOA formation under humid (i.e., 50% relative humidity, RH) and varying seed aerosol acidity conditions. Compared to their application in previous models, reducing the 2-methyltetrol (tetrol) reaction rate constants by a factor of 4 brings the model predictions in agreement with the IEPOX-SOA measurements with acidified ammonium bisulfate seed aerosols. For less acidic ammonium sulfate aerosols, we find that both the organosulfate (OS) and tetrol reaction rate constants need to be reduced to bring model predictions closer to chamber observations. Using the measured non-volatile content of IEPOX-SOA we constrain the oligomerization timescale of tetrols. We find that the oligomerization timescale is 4 hours with acidified seed aerosols, but a much longer timescale of 24 hours is needed for non-acidified aerosols, indicating that the aerosol acidity greatly affects the oligomerization rate of tetrols. Our results imply that IEPOX reactive uptake kinetics used in regional and global models, which are based on bulk aqueous solution measurements have likely overpredicted IEPOX-SOA formation from aqueous chemistry in the atmosphere.

9ES.6

Influence of Ecosystem Processes on Aerosol Organic Hygroscopicity. MARIA FLORES, Celia Faiola, *University of California, Irvine*

Secondary organic aerosol influences the transfer of radiation by scattering and absorbing light and acting as cloud condensation nuclei (CCN). The particular composition of aerosols influences how likely they are to take up water and act as CCN, a property that is often described with aerosol hygroscopicity. Many ecosystem processes, such as spring bud bursts and fall leaf senescence, can alter biogenic emissions and thereby alter overall aerosol hygroscopicity, but can also alter the hygroscopicity of the organic component in the condensed phase (k_{org}). Since climate change is altering many ecosystem processes, including seasonal phenology, it is important to have a better understanding of how these processes alter aerosol hygroscopicity to allow us to better predict aerosol climate effects.

This project leverages field data collected at DOE ARM sites. The field sites used for this study include the South Great Plains site in Oklahoma, and the SMEAR II station in Hyytiälä, Finland. First, the particle hygroscopicity, k_{CCN} was calculated by determining the maximum activated fraction as a function of particle size at different supersaturations. Secondly, the k_{org} was calculated by using ARM field campaign data derived from CCN hygroscopicity and particle composition. Finally, the k_{org} was compared between both sites to investigate the effects of plant emission types, seasonality, and other ecosystem properties and processes on aerosol hygroscopicity. A synthesis of that analysis will be presented.

9ES.7

Characterizing Local and Regional Contributions to the Aerobiome of the University of California, Irvine Campus. JASMINE OSEI-ENIN, Celia Faiola, *University of California, Irvine*

Bioaerosols account for approximately thirty percent of atmospheric aerosol loads in the coarse particle size range. The collective composition of bioaerosols that reside in the planetary boundary layer are referred to as the aerobiome. Atmospheric aerosols PM_{10} and $PM_{2.5}$ are regulated by the Environmental Protection Agency due to their negative impacts on human health, but it is unclear how the aerobiome composition could modulate this effect. The aerobiome can lead to positive or negative effects for humans by providing microbes that strengthen the immune system or transmitting pathogens, respectively, depending on the microbial composition. Urban areas with limited plant life have low aerobiome biodiversity, which has been linked to negative consequences for human and environmental health. Microbe contributions from soil, plants, and animals are believed to increase the biodiversity of local aerobiomes, but it remains unclear how proximity to these sources influence the microbial composition of a local aerobiome in an urbanized setting.

In this preliminary study, we compared and contrasted aerobiome composition between four sampling sites located on the University of California, Irvine campus across four seasons. Each sampling location was selected to represent different levels of greenness, types of vegetation, and local versus regional sources. Sampling locations at Aldrich park and San Joaquin Marsh represent high greenness with managed and natural vegetation, respectively, while collection at a parking lot was considered isolated from vegetation. One sampling location was the roof of Croul Hall, 121.5 meters above ground level, to observe the regional aerobiome of the campus. Using gravitational settling methods, bioaerosol samples were collected at 1.0 and 2.0 meter heights to capture the vertical range of air most experienced by children and adults because aerobiome composition exhibits steep vertical gradients near Earth's surface. Each aerobiome will be characterized from bioaerosol samples using a Zymobiomics micro kit and sequenced via Illumina 16s rRNA and ITS protocols for bacterial and fungi communities, respectively. With these findings, we can better understand the role of aerobiomes in the urban setting.

9ES.8

Properties of Biogenic Ice Nucleating Particles. SARAH D. BROOKS, Daniel Thornton, Brianna H. Matthews, Alyssa Alsante, Roya Safa, Phoebe Scharle, *Texas A&M University*

Ice crystals are important in clouds at all latitudes, affecting Earth's radiative budget and hydrological cycle. Aerosol may act as ice nucleating particles (INPs), catalyzing heterogeneous ice crystal formation at temperatures well above the freezing of pure water droplets. While INPs represent 1 in 10,000 (or fewer) aerosols in the troposphere, they are a controlling factor in many microphysical and precipitation processes and need to be better understood. While often discussed as a single aerosol type, the biogenic aerosol population includes pollen, marine aerosols, secondary organic aerosols and more. Our research results indicate that each of these subgroups has unique ice nucleating temperature and humidity requirements. Furthermore, emissions of biogenic aerosols depend on the regional environmental conditions in complex ways. Overall, biogenic aerosols and their influence on clouds present a major challenge in constraining the relationship between ecosystems and future cloud properties and precipitation.

9ES.9

Bioaerosol Analysis Using Photothermal Infrared Spectroscopy: Case Study with Aerosols from Cyanobacterial Harmful Algal Blooms. CARLIE POWOROZNEK, Jia Shi, Rebecca Parham, Katherine Kolozsvari, Yao Xiao, Nicole Olson, Johnna Birbeck, Stephen Jacquemin, Judy Westrick, Andrew Ault, *University of Michigan*

Freshwater systems constantly release particles into the air, called lake spray aerosol (LSA), which impacts the environment and human health. These aerosol particles can contain biological material. Not only can these bioaerosol particles act as effective ice-nucleating particles (INPs) and cloud-condensing nuclei (CCN) but they can also contain biogenic toxins. Freshwater systems can undergo cyanobacteria harmful algal blooms (cHABs) where there is a dramatic increase in biological activity. The effects cHABs have on the water have been decently studied but the resulting increase in the amount of bioaerosol has not been researched thoroughly. To understand the impact cHABs have on the environment and the health of residents nearby it is important to know the composition of the aerosol. However, single particle analysis of bioaerosol presents many challenges. The resolution needs to be below a few micrometers, limiting traditional infrared spectroscopy, and biological particles tend to fluoresce under increased energy, limiting Raman spectroscopy. To combat this photothermal infrared (PTIR) spectroscopy methods were used. Atomic force microscopy (AFM) PTIR and optical photothermal infrared (OPTIR) were used to analyze the individual particles from laboratory-generated aerosol taken from water containing a cHAB. These methods use a probe, a cantilever and a beam of visual light respectively, and changes in the deflection or the scattered light are measured as an IR source is activated to determine when the particle is IR active. The AFM-PTIR was able to measure particles with a diameter from 0.18 to 0.32 µm while the OPTIR analyzed particles with a diameter of 1.8-3.2 µm. Results showed that the percentage of biological particles increased significantly at larger particle diameters. These results not only are helpful in analyzing the impact of bioaerosol from cHABs, but also provide evidence for OPTIR and AFM-PTIR being useful techniques for future bioaerosol analysis.

9HS.1

Evolution of Filters for Aerosol Chemical and Physical Characterization. JUDITH CHOW, Xiaoliang Wang, John Watson, *Desert Research Institute*

Air has been drawn through porous materials for centuries to remove contaminants from inhaled air and more recently to obtain particles for subsequent analyses. Early characterization methods subjected the aerosol deposits to microscopic analysis and to measures of filter darkening as an indicator of particle concentrations. Weighing the filter before and after sampling became the standard method for determining aerosol mass loadings, and a wide range of chemical and physical analyses methods were subsequently developed and applied. These methods revealed limitations of the filter materials with respect to sampling efficiencies as a function of particle size, degree of penetration into the filter material, adsorption of gaseous pollutants and water vapor, excessive blank levels for the desired particle compositions, optical properties, loading capacities, durability, and cost. Filters that have been used for aerosol sampling include: 1) membrane (also termed “porous membrane”) filters (i.e., PTFE, polypropylene, PVC, nylon, silver, and mixed cellulose esters [MCE]); 2) capillary pore filters (i.e., polycarbonate Nuclepore); and 3) fibrous filters (i.e., cellulose-fiber, pure and mixed quartz-fiber, Teflon-coated glass-fiber, and glass-fiber). These filter types have undergone a variety of tests over the past 60 years for pairing with different sampling and analysis methods. Several of them are currently being evaluated for additional analytical methods that have not yet been applied to ambient aerosol analyses. The presentation intends to: 1) describe materials and structures of these filter types and how they evolved over time; 2) summarize past tests on filter collection efficiencies; 3) discuss potential atmospheric artifacts; 4) examine effects of particle deposit inhomogeneities; 5) tabulate filter costs and availability; and 6) identify future prospects for aerosol filter sampling to protect public health and identify pollution sources.

9IA.1

In-situ Assessment of Particle Air Cleaning. Rafsan Nahian, JEFFREY SIEGEL, *University of Toronto*

Air cleaner performance is context specific, and the same air cleaner will perform differently in different environments owing to differences in background loss rates (eg, deposition and ventilation), room mixing, and indoor and outdoor sources. Further the same air cleaner will perform differently over time for a given environment because of variations of these factors as well as air cleaner performance degradation. The goal of this research was to design and utilize an in-situ test to allow for in-situ testing of any particle air cleaner using low-cost instrumentation. The test switches between the operation of the air cleaner and a co-located sham air cleaner (a white noise generator that operates by moving air and creates the same sound pressure level as the air cleaner). The effectiveness can be explicitly calculated from the concentrations during placebo and air cleaner operation periods and the air cleaner loss rate can be calculated by the difference in the rates of decay of the pollutant of interest between the two periods. Here, we report on pilot tests in a residence to determine the appropriate duration of each air cleaner/placebo period, the overall duration of the test, the impact of different data analysis approaches (eg, truncating data from the beginning of each air cleaner/placebo period). The results suggest that a duration of each operation period of 2 hours 30 minutes, excluding the data from the first 30 minutes of each period, and an overall experimental duration of approximately 48 hours yielded robust results when compared to results collected over a week. Results were expanded to five different air cleaners and five different environments. The collective results show that the test is very sensitive and can detect air clean air delivery rates as low as 50 m3/h. The testing shows wide variability in the effectiveness of an air cleaner in a given environment over short time scales (largely owing to variations in ventilation as well as source patterns) and highlights the importance of in-situ measurements to characterize these variations.

9IA.2

Improved Biomass Stoves and and Improved Cooking Practices Contribute to Lowering PM2.5 Exposure in Addis Ababa, Ethiopia. Margaret Hall, Sophie McManus, Amadou Toure, Audrey Parrott, Ella Hein, Alek Rabago, Nora Caballero, Austin Heuer, Seblua Abebe, Tsegaye Nega, DEBORAH GROSS, *Carleton College*

Cooking with biomass fuels is well-known to be a significant health hazard for nearly 3 billion people, worldwide. While there are many initiatives designed to provide cooks with improved stoves and fuel, to minimize their exposure, these programs have not had the impact that is needed for achieving the United Nations Sustainable Development Goal 7, "Ensure access to affordable, reliable, sustainable and modern energy for all." Even when consumers have improved cookstoves, without appropriate fuel, appropriate training in stove operation, and access to sufficient fuel/stoves to cook what they need, they will not experience the benefits of the improved stove. Here we compare PM2.5 concentrations measured during ~100 cooking events in Addis Ababa, Ethiopia, in which cooks used traditional wood stoves, charcoal stoves, or improved fan-forced gasifier stoves burning pellets.The improvement realized with the improved pellet stoves is shown to be highly dependent on cooking practices, especially how the stove is lit and extinguished. The shorter cooking time required with the improved stove means that even when these practices are not perfect, the cooks' exposures are lower relative to when using traditional stoves. Implications for real-world use of these stoves will be discussed.

9IA.3

Moisture Influences Gene Expression and Allergens in Fungal Communities in House and ISS Dust. Ashleigh Bope, Nicholas Nastasi, Emma C. Hall, Bridget Hegarty, Rachel I. Adams, Allen Goldstein, Pawel K. Misztal, Karen C. Dannemiller, SARAH R. HAINES, *University of Toronto*

Microorganisms are found everywhere in our indoor environments, both in our buildings on Earth and on spacecraft such as the International Space Station (ISS). Fungal growth is limited by moisture availability with fungal growth increasing at elevated humidity conditions. Previous work has established a relationship between metabolic activity and moisture, however further work is needed to examine how microbial function in dust from both homes and the ISS are impacted by changes in moisture condition. A *de novo* metatranscriptome study was performed utilizing samples of dust from both homes and the ISS incubated at 50%, 85% or 100% equilibrium relative humidity (ERH) for a period of 7 - 14 days. Exposure of ISS dust to elevated humidity conditions (>80%) represents a simulated unexpected event such as a temporary ventilation system failure where relative humidity (RH) may increase above typical levels. In both ISS dust and Earth dust, transcription expression was tightly grouped by RH condition, meaning gene expression is likely a function of moisture availability. Additionally, in both ISS and Earth dust, genes associated with spore formation, germination and secondary metabolic processes were upregulated at elevated RH conditions. In Earth dust, toxin metabolic processes were upregulated at 100% ERH when compared to 50% ERH and genes for common mold species *Aspergillus fumigatus* and the Alt a 1 allergen from *Alternaria alternata* were expressed within the full transcriptome. Ultimately, metabolic activity of microbial communities found in dust on both Earth and the ISS were determined to be significantly impacted by variations in moisture conditions. Understanding how microbes react to increases in moisture will help us develop more robust microbial monitoring standards for spacecraft, and other indoor environments. Further work will explore the relationship between gene expression, allergens and toxins in our indoor environments.

9IA.6

Characterization and Modeling of Indoor Air Pollution in Urban Indian Built Environments. ALOK KUMAR THAKUR, Sameer Patel, *Indian Institute of Technology Gandhinagar*

Indoor air quality (IAQ) is an increasingly important concern in both developed and developing nations, as people spend 90% of their time indoors, with a significant portion of that time spent in their homes. Unlike developed nations, IAQ studies in urban built environments in India are limited in terms of both measurement and modeling. Limited work on IAQ in urban Indian build environments is restricted to PM mass concentration (mostly with low size resolution) and offline and online measurements of some gaseous species. The paucity of measurements inhibits further analysis required for built environment characterization and modeling of source, transport, transformation, and the fate of pollutants inside built environments.

The current study consists of longitudinal cross-sectional IAQ measurements in multiple built environments, including residential and non-residential spaces. While no interventions and prescribed activities were performed in most study sites, semi-controlled experiments were performed in one residential apartment to gain deeper insights. IAQ measurements included real-time aerodynamic particle size distribution data (~0.5-20 µm), $PM_{1,2.5,10}$ (using nephelometer and low-cost air quality monitors), CO_2, VOC, O_3, HCHO, and CO. In addition, thermal comfort parameters (RH & T) were also measured.

Indoor spatio-temporal and outdoor PM levels were captured by multiple units of low-cost air quality monitors. Spatio-temporal PM measurements provided insights into emissions sources profile and transport of emissions within the indoor space. The efficacy of different mitigation strategies, such as increased natural ventilation and portable air purifiers, was investigated. In addition, installing filters on indoor air conditioning units was also assessed as a mitigation strategy.

9IA.7

Performance Evaluation of Portable Indoor Air Cleaners: Particles and Organic Compounds Removal and Possible Byproduct Generation. DONG GAO, Elizabeth Lin, Sheng Liu, Krystal Godri Pollitt, *Yale University*

The rising concerns about indoor air quality have driven a growing interest in the use of portable indoor air cleaners for mitigating health risks associated with airborne contaminants, such as particulate matter, volatile and semi-volatile organic compounds (VOCs and SVOCs), and airborne viruses. This study aimed to evaluate the performance of four types of portable air cleaners, including a commercially available high-efficiency particulate air cleaner, an electronic air cleaner, and two lower-cost, do-it-yourself (DIY) alternatives built from box fans – one coupled with a MERV-13 filter and the other with activated carbon filters, to cover a wide range of applications and affordability. The focus was on assessing their efficiency in removing particles, VOCs, and SVOCs, as well as examining the generation of byproducts such as ozone. The experiments were conducted in a 3.5 m^3 Teflon chamber, spiked with wood smoke. The particle and ozone concentrations in the chamber were monitored continuously with an optical particle counter and a portable ozone monitor, respectively. Organic compounds were collected using passive sampling methods during different time intervals of operation and subsequently analyzed by thermal desorption gas chromatography high resolution mass spectrometry. The results showed all types of air cleaners excelled in particle removal, eliminating more than 95% of particles within 10 minutes of operation. The DIY activated carbon air cleaner demonstrated high efficiency in removing organic compounds, offering an affordable and efficient alternative for air purification needs. However, the electronic air cleaner with a charging system posed a risk of generating harmful oxidation byproducts, such as ozone or oxidized organic compounds, after 20 hours of operation. The findings provide valuable insights regarding the selection and implementation of effective air cleaning solutions to promote healthier indoor environments.

9IA.8

Modeling SOA Formation via Multiphase Reactions of Hydrocarbons under Indoor Light Environments. SPENCER BLAU, Myoseon Jang, *University of Florida*

The majority of the lives of many people in modern society is spent indoors. There are many Volatile Compound Products (VCPs) in indoor spaces. Examples of VCPs include cleaning agents, personal care products, paints, and pesticides. However, the full effect of these products on health is not currently known. Particularly, their atmospheric process in indoor environments has not been identified. The purpose of this study is to extend the UNIfied Partitioning Aerosol Reaction (UNIPAR) model to the prediction of Secondary Organic Aerosol (SOA) formation indoors. The UNIPAR-Indoor model utilizes lumping species that originates from explicitly predicted products, produced during the atmospheric oxidation of a precursor hydrocarbon, is employed to process products' multiphase partitioning and aerosol phase reactions. To demonstrate the model, toluene (aromatic hydrocarbon) and α-pinene (terpene) are chosen as they are the most abundant SOA-forming hydrocarbons present in indoor settings. The experiments are conducted using a 2.0 m^3 indoor Teflon film reactor which is equipped with commercialized cool fluorescent lamps or cool LED lamps. α-Pinene is examined in the presence of ozone with indoor light environments and without indoor light environments. The SOA formation from the oxidation of both toluene and α-pinene is also simulated by using UNIPAR-Indoor with indoor light environments under different NOx conditions. It also tests toluene and α-pinene together without indoor light environments to examine the impact of the OH radical biproduct from α-pinene ozonolysis on toluene oxidation.

9IA.9

Physiochemical Properties of Thirdhand Smoke Generated from Electronic Nicotine Delivery Systems. KAPIAMBA KASHALA FABRICE, Gabriel Georgakopoulos, Weixing Hao, Yue-Wern Huang, Yang Wang, *University of Miami*

We examined the physiochemical properties of thirdhand smoke (THS) generated from Electronic Nicotine Delivery Systems (ENDS). ENDS have gained significant popularity and raised public health concerns due to their potential adverse effects. The study aimed to characterize ENDS THS and understand how different material surfaces and environmental conditions influence its formation. Various common materials, including fabrics, stainless steel, and plastics, were exposed to simulated secondhand ENDS aerosols in a controlled chamber. After a 24-hour exposure period, the chamber was subjected to changes in environmental conditions, including changes in temperature (20 to 40 ºC), relative humidity (10 to 90%), and vibration (1 to 50 Hz). The emitted aerosols were analyzed for size distributions using particle sizers and chemical composition using inductively coupled plasma mass spectrometry and gas chromatography-mass spectrometry. The results revealed distinct aerosol size distributions and chemical compositions of ENDS THS depending on the type of contaminated surface. The size distribution analysis showed a bimodal distribution, with one fine-mode around 200 nm and another coarse-mode at 1 µm, while the number concentration ranged from 103 to 106 cm-3. Environmental factors such as temperature, humidity, and vibration were found to influence ENDS THS emission concentration and composition. In addition, we also observed trace metals associated with ENDS emission (Kapiamba et al., 2022), including Cr, Ni, Pd, Zn, and low concentrations of VOCs and carbonyls. These findings highlight the importance of assessing the health and environmental impacts of ENDS THS.

Kapiamba et al., Chem. Res. Toxicol., 35(6): 954-962.

9IA.10

Detection and Protection From Extreme Aerosol "Spikes" Generated during Everyday Cooking Activities.
DEVABHAKTUNI SRIKRISHNA, Sonam Devabhaktuni, Sathyaraj Devabhaktuni, *Patient Knowhow, Inc.*

Prior work characterized extreme levels of aerosol generation during cooking such as when frying oils/fats beyond the "smoke point" or burning bread during toasting. However, using low-cost particle counters we not only verified such extremely high levels of aerosols generated ("spikes") but unexpectedly discovered spikes also during everyday cooking activities in a duration-dependent and distance-dependent manner. These cooking activities included microwaving popcorn, making pancakes, and air-frying chicken nuggets. The spikes observed came as a surprise to many which were liked and shared over 1000 times on Twitter (https://twitter.com/sri_srikrishna/status/1614550657020858369). The spikes were often measured as much higher compared to a burning cigarette (second hand smoke) and ambient outdoor aerosols (PM 2.5) suggesting potential for health risks (e.g. cancer, cardiovascular, neurological, etc) from spikes during repeated exposure from everyday cooking activities. Whereas spikes were not detected during some other common activities such as boiling pasta on a stove and heating water with a microwave. Spikes were also detected in one instance using an electric stove with nothing cooked on it, which resolved once the filament was cleaned suggesting some food or substance on the filament may have caused it (https://twitter.com/sri_srikrishna/status/1623805459651260416). In most instances, air cleaning (e.g. ventilation, range hood, air filtration) may reduce spikes but air cleaning methods were insufficient to rapidly clear up spikes during the cooking activity close up to the source (short-range). However indoor aerosol counts were much lower at a distance (long-range) away from the point of cooking, a possible distance-dependent protective effect from these spikes diluted through mixing. In this research, we present a test matrix of aerosol measurements of spikes observed during a range of everyday cooking activities using both a more expensive, sensitive particle counter and lower-cost particulate monitors, nearby and at a distance, in presence of different levels of air cleaning (with range hood, ventilation with open windows, air filtration up to 12 air exchanges per hour). Given the unpredictability of spikes based on the cooking activity, duration, and distance these results motivate wider use of low-cost particle counters during cooking to offer real-time warning of potentially risky spikes, both close up and at a distance. These warnings can be used to selectively initiate (trigger) air cleaning for indoor occupants at a distance, and if air cleaning of indoor aerosols is inadequate, personal protection such as N95 respirators to protect those with direct exposure to spikes at close range such as cooks.

9IA.11

Impacts of Semivolatile Organic Carbons and Relative Humidity on the Deposition Rate of Ozone to Permeable Indoor Surfaces. JILLIAN DOWNEY, Jonathan Abbatt, *University of Toronto*

Ozone (O_3) reacts with unsaturated compounds, whose reaction products, when inhaled, can result in negative health effects. For many unsaturated molecules, the surface reactivity is over 100 times that in the gas phase. Given that indoor environments have a much higher surface area-to-volume ratio compared to outdoor environments, surface reactions play a huge role in establishing indoor air quality. O_3 loss rates on single-component, clean surfaces have been well studied. However, the indoor environment is complex, with many surfaces being permeable and/or covered in semivolatile organic carbons (SVOCs). Diffusion rates of O_3 into permeable surfaces depend on relative humidity (RH), and the partitioning of SVOCs may also be affected by RH. This suggests that RH will affect O_3 reactivity, however, an understanding of these processes is limited. This work addresses how O_3 deposition on a permeable surface (painted surface) is affected by a model unsaturated SVOC (terpineol) at different RHs. Firstly, to quantify O_3 deposition on a painted surface, O_3 was passed through a chamber (with painted surfaces on the top and bottom) and O_3 was monitored at varying RHs. Then, terpineol uptake on a painted surface was quantified by measuring the sorbed mass of terpineol using an online mass spectrometer at different RHs. Lastly, O_3-terpineol reactivity at varying RHs was studied, where O_3 was introduced to a terpineol-conditioned chamber. It was found that increased RH increases O_3 deposition and terpineol partitioning into the paint. Also, the presence of terpineol increases ozone deposition, emphasizing the importance of SVOC-O_3 surface reactions on indoor air quality.

9IA.12

Analysis of Significant Weather Events (Inversion, Dust, Wildfire Smoke) Impact on Indoor and Outdoor PM2.5 Levels Measured Using a Network of Low-Cost Air Quality Sensors. TRISTALEE MANGIN, Zachary Palmer, Darrah Sleeth, Kerry Kelly, *University of Utah*

Individuals spend up to 90% of their time indoors, and poor indoor air quality (IAQ) is associated with numerous adverse human health effects. Yet it has been less frequently studied than outdoor air quality. Particulate matter (PM), specifically PM2.5 concentrations, is a key driver of adverse health effects. We deployed 18 low-cost air quality sensor nodes that measure particle pollution and CO2 levels in 16 indoor and two outdoor locations across the University of Utah campus. Additionally, a dashboard was developed to share the AQ measurements in real time with facilities management. This study aims to understand the impact of pollution episodes (wildfires, dust events, and temperature inversions) on indoor air quality and to partner with facilities management to identify the effect of HVAC settings on IAQ. Thus far, our preliminary results identified PM2.5 levels that exceeded 40 ug/m3 during a wildfire event (more than three times WHO IAQ 24-hour guidelines) and numerous hours when PM2.5 levels exceeded the IAQ guideline during inversion events. Furthermore, one of the 16 indoor locations exhibited high correlations (R2 = 0.81) with outdoor AQ locations, although the other 13 indoor locations show moderate to low correlations (0.3 < R2 < 0.7). The ultimate goal is to help facility management optimize energy consumption, IAQ, and student/staff comfort and health.

9IA.13

Indoor Particle Characterization in Forty Commercial Building Offices in Singapore. ZURAIMI SULTAN, Jiayu Li, Jovan Pantelic, Stefano Schiavon, *UC Berkeley*

Little research has been conducted to study how office buildings protect occupants from exposure to particles of indoor and outdoor sources. Our research reports a cross-sectional empirical study involving weekly measurements of size-resolved indoor and outdoor particle concentrations in forty commercial building offices in Singapore. Indoor particle concentration was found to vary according to outdoor levels, particle-size, indoor particle removal rates, indoor particle of outdoor proportion (IPOP) and particle source strength. Indoor particle concentrations were significantly lower than outdoors, which indicates that the buildings have good indoor particle removal rates via filtration and ventilation, low indoor sources and low outdoor particle penetration through the ventilation system and building façade. Indeed, through generalized linear modelling analyses, indoor particle removal rate was found to be dependent on air distribution, use of supply air filters and paper utilisation. We found also lower IPOP for ultrafine than for fine particles via regression analyses of indoor and outdoor concentrations for each particle size. Daytime IPOP was significantly associated with air distribution and supply air filters while night time IPOP was lower in buildings with steel and glass facades. Lastly, regular daily cleaning was associated with lower particle source strengths. The contribution of outdoor sources was mainly seen for ultrafine and fine particles but less pronounced for coarse particles. We summarise that low indoor particle levels observed in Singapore office buildings is due to the effects of low indoor source contribution, low indoor particle of outdoor proportion and relatively high indoor particle removal rates.

9IA.14

Understanding the Fate and Composition of Indoor Particle Mix. CHETHANI ATHUKORALA, Suresh Dhaniyala, *Clarkson University*

Indoor airborne particle population constitutes both human-generated and outdoor-originated particles. The concentrations of indoor particles depend on the ventilation rates, efficiency of any inline and in-room filters in place, and the impact of mechanisms such as deposition and re-suspension. During COVID, it became clear that indoor particles generated by humans could have an impact on human health. In the absence of an ability to separate particles by source, it was deemed necessary to reduce the concentrations of all indoor particles. To minimize energy use, however, it would be best to identify just the threat particles, i.e., those emitted from human activities, and act to reduce their concentrations. In this study, we combine theoretical modeling with experimental data to extract information about human generated particles from real-world classroom activities. Using a network of research-grade instruments and low-cost sensors, we obtained comprehensive particle concentration and size distribution data over 18 months with varying classroom usage patterns, environmental conditions, and ventilation settings. Our analysis shows that human particle emissions are small fraction of total aerosol but a major contributor to super-micron particle population. The human-generated particle concentrations determined from our real-world study are lower than that estimated from laboratory studies. In this presentation, we will present our approach to extract information about the human-generated particle population from indoor air measurements that are dominated by outdoor particles. We will also highlight the relation between operational changes of building ventilation system with the indoor air quality in the room.

9IA.15

Particle-Phase Ionic Per- and Polyfluoroalkyl Substance (PFAS) Profiles, Concentrations, and Artifacts in Indoor Air: Findings from the Indoor PFAS Assessment (IPA) Campaign. NAOMI CHANG, Clara Eichler, Daniel Amparo, Jiaqi Zhou, Elaine Cohen Hubal, Jason Surratt, Glenn Morrison, Barbara Turpin, *UNC-Chapel Hill*

PFAS are a class of >12,000 synthetic compounds that persist in the environment, and some have been associated with adverse health effects including cancers and reduced immune response in children. Although PFAS-containing consumer products are commonly used indoors, few indoor air measurements of PFAS have been reported. To address this knowledge gap, the UNC Indoor PFAS Assessment (IPA) Campaign sampled various environmental matrices in 10 homes in North Carolina over 9-months. Quartz fiber filters (QFF) are the standard collection substrate for particle-phase PFAS. However, QFFs are known to adsorb organic gases, in addition to collecting particles. Thus, in the IPA Campaign, we collected $PM_{2.5}$ with two QFFs in series (6-day collection), where the backup QFF provides an estimate of the adsorption artifact. PFAS were quantified using an AB Sciex Triple Quad UHPLC-ESI-MS/MS for 26 ionic PFAS. Eight PFAS (6:2 diPAP, PFBA, PFHpA, PFHpS, PFHxA, PFOA, PFOS, and PFTA) were above detection limits in over 50% of front and/or backup QFFs indicating gas-phase adsorption to both filters. Front filter concentrations of PFOA and PFOS were significantly higher than backup filter concentrations, suggesting that particle-phase PFOA and PFOS were present on the front filter. For the conditions of this study, at least 29% and 37%, respectively, of the median front filter concentrations of PFOA (0.58 pg/m^3) and PFOS (0.56 pg/m^3) are attributable to gas-phase adsorption. Therefore, previously reported particle-phase PFAS concentrations may be overestimates. We are investigating other feasible filter collection methods for separate gas and particle-phase collection. To our knowledge, the IPA Campaign is the first study to report $PM_{2.5}$ filter collected ionic PFAS in United States homes.

Disclaimer: The views expressed in this presentation are those of the authors and do not necessarily represent the views or policies of the U.S. EPA.

9IA.16

Assessing Microbial and Chemical Exposures in Beaumont, Texas. DAVID JARMA, Juan Pedro Maestre, Pawel K. Misztal, Kerry Kinney, *University of Texas at Austin*

We spend roughly 90% of our time indoors, so it is important to understand the environmental factors that affect indoor air quality as indoor exposures to particulate matter (PM) can be higher than outdoor exposures. PM-associated contaminants of concern include fungi, bacteria and chemical contaminants such as flame retardants and phthalates. Environmental justice communities such as Beaumont, Texas are subject to acute flooding events that can lead to the proliferation of mold as well as chronic chemical exposures due to the major petrochemical facilities located in this area. Additionally, such disadvantaged areas frequently have poorer health outcomes and life expectancy rates below the national average. In this study, home PM-associated contaminants were assessed via dust samples collected from 40 homes in Beaumont, Texas during the summer to explore household exposures to microbial and chemical pollutants.

Microbial DNA was extracted using the Applied Biosystems, MagMAX Microbiome Ultra Nucleic Acid Isolation Kit, and the resultant bacterial and fungal DNA were analyzed - 16S and ITS - on the MiSeq genomic sequencing platform. SVOCs are being analyzed with a novel technique capable of direct, untargeted analysis of hundreds of compounds. Household information about the presence of indoor mold, home location in relation to water, household materials, and cleaning regime were collected via REDCap online survey.

Relationships between environmental factor survey data, microbial sequencing data, and SVOC data are being investigated. In order to foster better human health, it is crucial to study and understand pollutant exposures and their sources in the spaces we frequent most often, particularly in vulnerable communities.

9IA.17

Real-Time Evaluation of VOC Emission Factors and Intake Fractions for Scented Wax Products Using PTR-TOF-MS.

JIANGHUI LIU, Jinglin Jiang, Satya Patra, Xiaosu Ding, Jordan Cross, Brandon E. Boor, Nusrat Jung, *Purdue University*

Scented wax products, such as candles and wax warmers, are a sub-class of volatile chemical products (VCPs) that are commonly used in residential buildings in the U.S. Significant quantities of wax are manufactured for use in such products, with more than 10^8 kg of wax used for candle production alone in the U.S. each year. As many candles and wax warmers are intentionally fragranced to produce pleasant aromas and indoor smellscapes for occupants, scented wax products may represent an important source of volatile organic compounds (VOCs) to indoor and urban atmospheres. The aim of this study is to evaluate VOC emission factors (EFs) and intake fractions (iFs) for scented wax products to better understand their impact on atmospheric chemistry and chemical exposures. Full-scale indoor emission experiments were conducted in the Purdue zero Energy Design Guidance for Engineers (zEDGE) Tiny House using a variety of scented candles (*n*=5) and wax warmers (*n*=14) under different outdoor air exchange rates (AERs). VOC concentrations were measured in real-time (1 Hz) using a proton transfer reaction time-of-flight mass spectrometer (PTR-TOF-MS) with hydronium (H_3O^+) as the reagent ion. A material balance model was used to estimate speciated EFs and iFs during indoor use of scented wax products. PTR-TOF-MS measurements revealed that scented candles and wax warmers emit a variety of monoterpenes ($C_{10}H_{16}$) and monoterpenoids ($C_{10}H_{14}O$, $C_{10}H_{16}O$, $C_{10}H_{18}O$, $C_{10}H_{20}O$), among other VOCs, with concentrations in the range of 10^{-1} to 10^2 ppb. Monoterpene EFs were much greater for wax warmers ($C_{10}H_{16}$ EFs ~ 10^2 mg per g wax consumed) compared to scented candles ($C_{10}H_{16}$ EFs ~ 10^{-1} to 10^0 mg per g wax consumed). Thus, wax warmers are more heavily fragranced compared to scented candles. VOC iFs were similar between the two ($C_{10}H_{16}$ iFs ~ 10^3 ppm) and increased with decreasing outdoor AER. Significant emissions of monoterpenes, which are highly reactive with ozone (O_3) and the hydroxyl radical (OH), suggest that scented wax product use may contribute to secondary organic aerosol (SOA) formation in indoor and urban atmospheres.

9IA.18

Impact of Wildfire Smoke Age and Filter Smoke Exposure on Air Cleaner Effectiveness.

RYAN BIXLER, Brett Stinson, Baorong Luo, Elliott Gall, *Portland State University*

Wildfires are increasing in frequency and intensity in the U.S., emitting substantial quantities of air pollution. During extreme wildfire smoke events, indoor environments are challenged by particulate and gas-phase air pollution orders of magnitude higher than non-wildfire smoke periods. Air cleaning is an essential tool to address indoor exposures to wildfire smoke, though better understanding of air cleaner performance under a persistent, elevated smoke challenge condition is needed. In this work, we describe a novel experimental device that enables control over the generation of wildfire smoke proxies suitable for laboratory environments. The device is a glass tube furnace with ring heater attached to a linear actuator; this device enables control over burn temperature, fuel feed rate, fuel type, and combustion gas type and flowrate. First, this device will be programmed and evaluated, aiming to create persistent conditions representative of an indoor space challenged by elevated smoke. Several common air cleaners will be evaluated with pull-down tests to determine particle clean air delivery rates (CADR) at regular intervals over a ~1-week period when challenged by high “fresh” smoke levels. Next, we will explore the impact of smoke age on air cleaner efficiency by comparing CADRs determined when an air cleaner is exposed to fresh smoke vs. smoke aged in the dark between 2-48 hours. Finally, we will explore the impact light and oxidant addition (ozone) on the evolution of fresh wildfire smoke in the chamber and its impact on air cleaner CADR. The data from this study will contribute to an improved understanding of how to generate repeatable proxies of wildfire smoke for controlled lab testing and how changes in smoke challenge may yield impacts on measurements of air cleaner performance.

9IA.19

Evaluation of the Effectiveness of Pre-filter Systems in Reducing PM2.5 Concentrations in Indoor Environments. SU-GWANG JEONG, *Soongsil University*

The indoor air quality in most urban environments is adversely impacted by outdoor air pollutants. To mitigate the levels of PM2.5, filtered ventilation systems have been made mandatory in newly constructed buildings. This study aimed to assess the impact of pre-filter systems on PM2.5 concentrations before and after installation, as well as to examine their behavior under different relative humidity conditions. Two houses (A and B) with identical ventilation systems were selected for the study. A high-performance filtering system was installed to reduce PM2.5 concentrations in the indoor air. Results showed that pre-filters were more effective in reducing outdoor PM2.5 rather than indoor-generated pollutants. After installation, the percentage of PM2.5 concentrations below 10 µg/m3 increased for both houses. The ventilation system proved to be more efficient in maintaining indoor air quality than an air cleaner. The study also revealed that relative humidity influenced the performance of pre-filters, with a higher percentage of I/O ratios (range of 0-1) after pre-filter installation in higher relative humidity conditions.

9IA.21

Secondhand Exposure to Simulated Cannabis Vaping Aerosols. XIAOCHEN TANG, Vi Rapp, Marion Russell, Hugo Destaillats, *Lawrence Berkeley National Laboratory*

Cannabis vaping is increasingly popular in the United States, especially among adolescents. Vitamin E acetate (VEA, $C_{31}H_{52}O_3$, MW: 472 g/mol) is a compound of low volatility, reportedly used as a thickening agent or to dilute cannabinoids in illicit vaping products. It was found in many e-cigarettes associated with the outbreak of vaping product-associated lung injury (EVALI) in 2019 and 2020, and is considered to be a key factor associated with the disease. Despite the growing amount of research on chemical emissions from cannabis use, little is known about the influence of low-volatility components, including VEA and cannabinoids, on the generation of aerosols and thermal degradation byproducts during vaping or dabbing.

This study explored how vaping liquid formulation affects the particle number and mass concentration of the formed aerosols and their chemical composition, by generating vaping aerosols from liquids of different composition under standardized conditions in a 20 m^3 environmental chamber. A mixture consisting of common terpenoids found in cannabis extracts was incrementally enriched in low-volatility constituents, including VEA and the cannabinoids trans-Δ9-tetrahydrocannabinol (THC) and cannabidiol (CBD). Aerosol particles between 8 and 2,500 nm in size, generated by heating mixtures of various compositions at 400 °C, were monitored in real time with a Fast Mobility Particle Sizer, an Optical Particle Sizer and an Aerodynamic Particle Sizer spectrometer. In addition, airborne species were collected in sorbent tubes and analyzed by gas chromatography/mass spectrometry, and volatile carbonyls were sampled in dinitrophenylhydrazine-coated cartridges, extracted, and analyzed by liquid chromatography. These results were used to determine the aerosol yield and particle decay rates inside the chamber. The Multiple Path Particle Dosimetry (MPPD) model was used to predict the deposition of different vaping aerosols in the human respiratory tract, for subjects of different ages. Lung deposition increased with the presence of VEA and cannabinoids.

9IA.22

Airborne Per- and Polyfluoroalkyl Substances (PFAS) in North Carolina Firehouses. GABRIELLE WEST, Clara Eichler, Naomi Chang, Rebecca Turner, Barbara Turpin, Jason Surratt, *University of North Carolina at Chapel Hill*

Since the 1940s, per- and polyfluoroalkyl substances (PFAS) have been manufactured for use in consumer and industrial products because of their water-, grease-, and heat-resistant properties. The ubiquity of PFAS in both indoor and outdoor environments remains an ongoing field of study. Firehouses are a unique indoor environment that remains critically understudied with regards to PFAS. PFAS are used to treat firefighting personal protective equipment and are a major component of aqueous film forming foams (AFFF), which are used to suppress liquid fuel-based fires. The usage and storage of these materials and equipment in firehouses can result in both direct and indirect exposure of firefighters to PFAS. Despite the known health risks associated with some PFAS, very limited exposure-relevant measurements have been made to identify and quantify PFAS in aerosol, gases, surfaces, and clothing in firehouses. This study aims to improve our understanding of the routes of exposure to PFAS in firehouses, identify/quantify PFAS at the molecular level, and to increase understanding of the partitioning and dynamics of PFAS within the unique indoor environment of firehouses. To this end, gas phase, fine particulate matter (diameter ≤ 2.5 µm), dust, glass surface wipe, and suspended cloth samples were collected from both the living space and the apparatus bay of three North Carolina firehouses. The samples were analyzed for 32 individual PFAS via ultra-high performance liquid chromatography-electrospray ionization tandem mass spectrometry (UHPLC/ESI-MS/MS) and gas chromatography-electron ionization mass spectrometry (GC/EI-MS) with authentic standards. This study is designed to inform future occupational exposure and risk assessments that could further guide firehouse practices and policies to protect health.

9IA.23

Atmospheric Multiphase Oxidation of Bisphenol A and Its Alternatives: Transformations and Kinetics in Air. JIE YU, Yufeng Gong, Hui Peng, Jonathan Abbatt, John Liggio, *University of Toronto*

The industrial chemical bisphenol A is widely used in the production of polycarbonate and epoxy resins, flame retardants and many other plastic consumer products for decades. But it is also a well-known endocrine disruptor that is exposed to humans via multiple exposure pathways and has raised many health concerns. The use of bisphenol A is banned in baby products in the US, Canada and EU, and so a broad class of bisphenol A alternatives – structurally similar to BPA – has been developed and used in “BPA-free” products. Little research has been done on the safety of these alternatives, but some alternatives have shown indications of being endocrine disrupting. Given the ubiquitous presence of bisphenol A and its alternatives in ambient aerosol particles and dust samples, the potential to undergo heterogeneous oxidation with atmospheric oxidants is high. However, prior studies only looked at the fates of bisphenols in surface water during wastewater treatment. For other environmental compartments, their transformation pathways with the presence of various oxidants are largely unknown. Uncertainties remain in the loss kinetics of the parent chemicals, the transformation pathway of the oxidized products, and the associated health impacts of the products.

This is the first study to assess these uncertainties by performing both gas-surface and gas-aerosol phase oxidation of Bisphenol A and some alternatives under atmospherically-relevant oxidation conditions, with a focus on the kinetics and transformation mechanisms. Laboratory heterogeneous oxidation was conducted in oxidation flow reactors (OFR) with important atmospheric oxidants O3 and OH. Both thin films of the reactants and suspended particles were used with, respectively, offline analysis by LC-ESI-MS and online analysis by an extractive electrospray ionization MS (EESI-MS). The major transformation pathways are proposed for oxidation conditions. These preliminary results will be valuable in evaluation of the toxicity and human exposure level of these oxidation products.

9IA.24

Particle Emission and Metal Composition Characterizations for Fused Filament Fabrication 3D Printers Using Emerging Materials. QIAN ZHANG, Rodney J. Weber, Todd Luxton, Derek Peloquin, Eric Baumann, Marilyn Black, *UL Research Institutes*

Fused filament fabrication (FFF) 3D printers have been gaining popularity and are widely used in non-industrial indoor environments. Studies have shown FFF 3D printing emits ultrafine particles and have indicated it as an emerging source of micro- and nano-plastics. However, as the 3D printing market is growing rapidly with continuously emerging technologies and materials, characterization of particle emissions from new materials such as composite filaments is needed. Particularly for filaments containing metal composites and/or additives, the potential of releasing metals in emitted particles is not well known. In this study, we utilized a standardized chamber study method to characterize particle emissions from various pure polymer and composite filaments. We measured particle size distributions using a scanning mobility particle sizer and an optical particle sizer and calculated particle emission factors for each print condition. In addition, we collected particle filter samples and analyzed them for metal composition using inductively coupled plasma mass spectrometry. Metal composition of raw filaments was also analyzed. We found that metal composite filaments generated a different trend in particle size distributions from polymer and polymer composite filaments, where metal composite filaments generated lower particle number but higher particle mass emissions. By comparing the metal composition in the raw filaments and emitted particles, we identified some metals associated with filament additives were enriched in the particles, while metals associated with metal powder composites were less likely to transfer into particle emissions. In addition, we found that the printer itself can be a source of metal emission in particles. Overall, FFF 3D printing emits high levels of ultrafine particles containing metal components, which could potentially pose a health concern when inhaled.

9IA.25

Chemical Properties and Toxicity of Cooking Aerosols (Meat and Fish). YEONJU SIM, Minhan Park, Kihong Park, *Gwangju Institute of Science and Technology*

Cooking activities are a significant source of indoor air pollution,s particularly fine particulate matter (PM2.5). However, research on the toxicity associated with fine particles generated by cooking is limited compared to studies on their physical and chemical properties. This study aims to compare the properties of toxicity between commonly consumed domestic pork and mackerel by simulating the grilling process in a self-designed cooking chamber. Filters were used to capture the emitted fine particles, and their chemical composition, including ions, elements, organic carbon (OC), elemental carbon (EC), water-soluble organic carbon (WSOC), water-insoluble organic carbon (WISOC) were determined. Oxidative potential (OP) of chemical toxicity was observed. Also, inflammatory responses, cell viability, and DNA damage of the fine particles were analyzed using lung cancer cells (A549).

Chemical composition data showed that organic carbon compounds constituted the majority of PM2.5 for both pork and mackerel. Organic carbon accounted for over 90% of the total carbon content in both types of meat. Pork exhibited a WISOC to organic carbon ratio was 92%, while mackerel had a ratio of 78%. Emissions factors were 26.69µg/g for pork and 37.94 µg/g for mackerel. Mackerel's OP was approximately 4.3 times higher than pork, with a value of 35.07 pmol/min/µg. There was no significant difference in cell viability between mackerel (86.82 µg/ml) and pork (79.60 µg/ml). In terms of immune responses, both pork and mackerel exhibited a significant increase compared to the control when exposed to a concentration of 5 µg/ml or higher. Principal component analysis (PCA) revealed that mackerel was associated with WSOC, elements, OP, and inflammatory responses, while pork was associated with WISOC and cell toxicity.

In conclusion, the significantly higher OP and emissions factor for fine particles from cooking mackerel suggests that they may pose a greater health risk compared to grilling pork belly.

9IA.26

Effects of E-Cigarette Liquid Ratios on the Gravimetric Filter Correction Factors and Real-Time Measurements. Austin Close, Jane Blackerby, Heather Tunnell, Jack Pender, Eric Soule, SINAN SOUSAN, *East Carolina University*

Electronic cigarettes (ECIGs) generate high concentrations of particulate matter (PM), impacting the air quality inhaled by humans through secondhand exposure. ECIG liquids are available commercially and some users create their own "do-it-yourself" liquids, and these liquids often vary in the amounts of their chemical ingredients, including propylene glycol (PG) and vegetable glycerin (VG). Previous studies have quantified PM concentrations in ECIG aerosol generated from liquids containing different PG/ VG ratios. However, the effects of these ratios on aerosol instrument filter correction factors needed to measure PM concentrations accurately have not been assessed. Thus, ECIG aerosol filter correction factors for multiple aerosol instruments (SMPS+APS, MiniWRAS, pDR, and SidePak) were determined for five different PG/VG ratios 1) 0PG/100VG, 2) 15PG/85VG, 3) 50PG/50VG, 4) 72PG/28VG, and 5) 90PG/10VG and two different PM sizes (1 µm and smaller and 2.5 µm and smaller). ECIG aerosols were generated inside a controlled exposure chamber using a diaphragm pump and a refillable ECIG device for all the ratios. In addition, the aerosol size distribution and mass median diameter were measured for all five ECIG ratios. $PM_{2.5}$ correction factors (5-7.6) for ratios 1, 2, 3, and 4 were similar for the SMPS+APS combined data, and ratios 1, 2, 3 were similar for the MiniWRAS (~2), pDR (~0.5), and SidePak (~0.24). These data suggest different correction factors may need to be developed for aerosol generated from ECIGs with high PG content. The higher correction factors for the 90PG/10VG ratio may have resulted from greater PG volatility relative to VG and sensor losses. The correction factors (ratios 1-4) for particles 2.5 µm ($PM_{2.5}$) and smaller were SMPS + APS data (4.96 – 7.62), MiniWRAS (2.02 – 3.64), pDR (0.50 – 1.07), and SidePak (0.22 – 0.40). This data can help improve ECIG aerosol measurement accuracy for different ECIG mixture ratios.

9IA.27

Infiltration of Outdoor PM2.5 Pollution into Homes with Evaporative Coolers in Utah County. DARRELL SONNTAG, Han Jung, Tyler Peterson, Taylor Christensen, Selah Willis, Pablo Harline, Paula Chanthakhoun, Alisandra Olivares, Jim Johnston, *Brigham Young University*

Evaporative "swamp" coolers are an energy-efficient form of air conditioning used in some homes in arid and semi-arid climates, including Utah. Compared to homes with central air conditioning, evaporative coolers introduce large volumes of outdoor air into the home. This may be beneficial for reducing indoor exposure to indoor sources of pollution but is a health concern when outdoor concentrations of fine particulate matter (PM2.5) are elevated, such as during wildfires.

In the summer of 2022 and 2023, we conducted a study measuring indoor and outdoor PM2.5 concentrations from 28 non-smoker homes in Utah County during the summer months, including several days with wildfire smoke. The participants agreed to minimize sources of indoor air pollution by agreeing not to cook, vacuum, use candles, incense or humidifiers. We measured minute-by-minute PM2.5 concentrations using TSI SidePak light-scattering photometers and daily average PM2.5 concentrations using Personal Environmental Monitors (SKC Ltd) with Teflon filters. We targeted collection from 14 homes with evaporative coolers, and 14 homes with central air conditioning. Our initial results from the summer of 2022 suggest that homes with evaporative coolers experience higher infiltration of outdoor PM2.5 pollution than homes with central air conditioning. At this conference we intend to present the results from our completed study.

9IA.28

Significant Differences in Ultrafine Particle Concentrations and Size Distributions between Cannabis Cultivation and Processing Facilities.

DAVI DE FERREYRO MONTICELLI, Cynthia Pham, Sahil Bhandari, Angela Eykelbosh, Sarah Henderson, Amanda Giang, Naomi Zimmerman, *University of British Columbia*

Cannabis cultivation and cannabis processing are emerging industries with poorly understood emissions. Information about ultrafine particles (UFP) is scarce and size distribution information has not been widely reported. In this study we deployed a Fast Mobility Particle Spectrometer (FMPS, model 3091, from TSI Instruments) in different rooms within a cannabis cultivation facility and processing facility. For 16 days across June-July 2023, we sampled in the Mother, Vegetation, Grow (early stage), Packaging, and Storage rooms of a cultivation facility and in the Grinding, Ethanol, Distillation, Formulation, Pre-Roll, and Packing room of a extraction and processing facility, covering almost the full life cycle from early plant development to final product. At least one day of continuous sampling was taken per room. While the constant action of mechanical ventilation, dehumidifiers and charcoal filters in cultivation rooms significantly reduced the UFP concentrations (most of the time to <1000 #/cm3), in the processing rooms which had a single exhaust that operated in cycles, concentrations were much higher (in some cases above 100,000 #/cm3). The one-minute average shape of distributions (i.e., unimodal, bimodal, multimodal) and peak modes (p-mod) in the cultivation facility rooms were: Mother (bimodal, p-mod = 80nm and 450nm), Vegetation (unimodal, p-mod = 80nm), Grow no pesticides (unimodal, p-mod = 124nm), Grow with pesticides (unimodal, p-mod = 6nm), Storage (bimodal, p-mod = 6nm and 124nm), Packing (unimodal, p-mod = 107nm). For the processing facility rooms: Grinding (bimodal, p-mod = 6nm and 45nm), Ethanol (unimodal, p-mod = 93nm), Distillation (unimodal, p-mod = 45nm), Formulation (unimodal, p-mod = 93nm), Pre-Roll (unimodal, p-mod = 34nm), and Packing (unimodal, pmod = 60nm). Understanding these effects will support policy makers and facility managers to coordinate efforts towards reducing exposure for workers and overall improved air quality.

9IA.29

Spatial Distributions of Skin Care Products (Fragrances or Lotions) in a Ventilated Room.

YOUNGBO WON, Pascale Lakey, Nora Zannoni, Jonathan Williams, Manabu Shiraiwa, Donghyun Rim, *Pennsylvania State University*

Indoor use of personal skin care products, such as fragrances and lotions, leads to the dispersion of chemical species into the surrounding air. Many of these chemicals interact with indoor reactive species, such as ozone and OH radicals, creating non-uniform spatial distributions of chemical species and reaction products, especially near the human body. This study investigates the spatial distribution of chemical species emitted from personal care products applied by indoor occupants.

The investigation employs a Computational Fluid Dynamics (CFD) model to simulate experimental conditions in a ventilated chamber with four occupants while maintaining an air change rate of 3 h^{-1}. During the experiments, ozone was introduced at a concentration of 122 ppb, and the time-varying emissions from skin care products and their reaction products were monitored over a 20-minute period.

The results show that when fragrances are applied to the wrists, species such as limonene, monoterpene, and ethanol follow the upward buoyancy airflow around occupants, driven by the occupant's thermal plume, and disperse into the ambient air. The concentrations of these species above the occupants' heads rapidly increase for three minutes and then gradually decrease due to ventilation and reactions. When lotions are applied to the face, neck, arms, and legs, species like ethanol and phenoxyethanol form a candle-like natural convection flow around the occupants, also influenced by the thermal plume effect. The peak concentration of these species occurs 18 minutes after applying the personal care products, with notably higher concentrations observed above the human head and chest, reaching levels 5-6 times greater than those in the ambient air. Overall, this study provides valuable insights into the dispersion and behavior of chemical species from personal care products used indoors, shedding light on the implications for indoor air quality and occupant exposure to these substances.

9ID.1

A Meta-Analysis of Air Change Rate and SARS-CoV-2 Exposure in Residences and Healthcare Facilities.

YUETONG ZHANG, Sripriya Nannu Shankar, William Vass, Z. Hugh Fan, John Lednicky, Duzgun Agdas, Chang-Yu Wu, *University of Florida*

As SARS-CoV-2 swept across the globe, increased ventilation and implementation of air cleaning were emphasized by the US CDC and WHO as important measures to reduce the risk of inhalation exposure to the virus. To assess whether higher ventilation and air cleaning rates lead to lower exposure risk to SARS-CoV-2, a comprehensive literature review of 1274 studies published between April 2020 and September 2022 were screened for relevancy. Among them, 93 field sampling studies that took place in residences and hospitals were selected, and associated data were compiled. Two metrics were used to assess exposure risk: (1) the concentration of SARS-CoV-2 in air samples and (2) the percentage of air samples in which SARS-CoV-2 was detected. Locations were categorized by type (hospital or residence) as well as by proximity to the sampling location housing the isolated/quarantined patient (primary or secondary). The positivity rates for primary and secondary sites were computed, and subsequently, the outcomes were grouped based on the air changes per hour (ACH) of the primary locations. The ACH were higher in hospitals (mode = 6) compared to residences (mode < 1), and the mean virus concentration in hospital settings (281 copies/L of air) was lower than that in residences (3.96×10^7 copies/L of air). The mean positivity rate in air samples collected in hospital settings (17.7%) was lower compared to that in residential settings (39.8%). In residences, positivity rates and concentrations were found at similar levels whether in primary or in secondary rooms, which may be explained by the low ACH. Our analyses show that on average SARS-CoV-2 may be present in greater concentrations in residential spaces than in hospital rooms, supporting the notion that a higher air change rate can reduce potential exposure risks to the virus in ambient air.

9ID.2

A Computational Model of Phonation-Induced Aerosolization.

COREY LYNN MURPHEY, Allison Hilger, Elizabeth Bradley, *University of Colorado - Boulder*

Human phonation induces the formation and ejection of aerosols from the mouth. In infectious speakers, phonation-induced aerosolization can facilitate the transmission of airborne viruses. However, the formation of such aerosols is challenging to visualize experimentally due to the complex structure of the larynx, the inability to directly measure aerosol generation at the laryngeal level, and the length scale at which fluid atomization occurs. Further, an experimental aerosol formation study employs an aerosol particle sizer (APS) that only measures exhaled aerosols, which have been filtered within the intermediate vocal tract between the larynx and the mouth. To understand the mechanisms involved in laryngeal speech-induced aerosol formation, we have developed a computational framework that models the ejection and subsequent breakup of sessile liquid on the surface of the vocal folds. A vibration-induced Faraday instability drives the emission of droplets from the fluid-lined mucosal layer of the vocal folds. We apply Tate's law to simulate the resulting droplet ejection. This vibration-induced atomization model accounts for nonlinear vibrational elastodynamics and fluid-structure interaction between exhaled air and the vocal fold tissues. The output of this model yields a spray distribution that we compare to experimental aerosol size distributions collected during phonation tasks.

9ID.3

Overview of the Size of Respiratory Particles Containing Infectious Pathogens.

TIMOTHY SIPKENS, Rym Mehri, Andrew Oldershaw, Gregory Smallwood, *National Research Council Canada*

The size of respiratory particles that contain infectious pathogens is an important quantity in driving communication about specific diseases and the recommended mitigation efforts. For example, there has been discussion around whether bioaerosols, which may be associated with larger particles than other hazards like dust or soot, can have relaxed particle filtration requirements, e.g., in the context of respiratory protection for the general public. In this respect, the size dependent particle filtration efficiency of many products could then be exploited, still blocking ~99% of relevant pathogens while allowing for increased breathability by relaxing the typical sub-micron particle filtration efficiency. However, questions remain around the particle sizes relevant to disease transmission, requiring summaries of existing data on the topic. Certain aspects of the problem may be reasonably well understood. A number of recent works have provided some discussion of the droplet–aerosol distinction, including tracing its lineage, providing some discussion of its relationship to particle size, and acknowledging that there may now be a shift in thinking about disease transmission (Jimenez et al, 2021; Randall et al, 2021). The size range of human-generated aerosols has also seen a fair amount of study, see Bourouiba (2021). Even in this case, data will naturally contain uncertainties due to human factors. Some recent work has also summarized some aspects of these transmission pathways, in particular for viruses (Wang et al, 2021). Here, we supplement these studies with a summary of the state of knowledge with an explicit focus on particle size, including identifying persisting gaps that remain in the literature and spanning across a broader range of pathogens. Hereby, we identify future research avenues to close some of the gaps, and to aid policymakers in better responding to future and existing respiratory infectious diseases.

9ID.4

Aerodynamic Size Distribution and Rates of SARS-CoV-2 Aerosol Shedding: Omicron BA.4 and BA.5.

KRISTEN K. COLEMAN, Petri Kalliomäki, Jianyu Lai, Sheldon Tai, Jennifer German, Filbert Hong, Barbara J. Albert, Yi Esparza, Aditya Kiran Srikakulapu, Maria Schanz, Isabel Sierra Maldonado, Molly Oertel, Naja Fadul, Arantzazu Eiguren-Fernandez, Gregory S. Lewis, Kathleen McPhaul, Donald K. Milton, *University of Maryland School of Public Health*

Understanding the aerodynamic size distribution and rate of viral aerosols shed by individuals infected with SARS-CoV-2 variants can help inform the utility of COVID-19 mitigation measures designed to reduce infectious aerosol inhalation. Here, we report the rates of viral aerosol shedding among Omicron BA.4 and BA.5 cases and the aerodynamic size distribution of exhaled breath aerosol particles carrying SARS-CoV-2 RNA. From June 15 through December 15, 2022, we recruited 27 individuals with PCR-confirmed COVID-19 to provide 30-minute breath samples into a Gesundheit-II (G-II) exhaled breath aerosol sampler. Among these individuals, 17 provided an additional exhaled breath sample into the newly designed Biocascade Exhaled Breath Sampler (BEBS). We quantified samples for viral RNA using reverse transcription digital polymerase chain reaction (RT-dPCR) and determined the viral RNA copies collected within two aerosol size fractions (≤5 µm and >5 µm in diameter) from the G-II, and four aerosol size fractions (<1.15 µm, 1.15–3.2 µm, 3.3–8.2 µm, and >8.2 µm) from the BEBS. Individuals with a BA.4 or BA.5 infection shed virus in aerosols at an average rate of 7.5×10^3 RNA copies per 30-minute G-II sample, with 78% of the total RNA in aerosols ≤5 µm in diameter. Among the BEBS samples, 10% of the total viral RNA was detected in aerosols <1.15 µm, 43% in 1.15–3.2 µm, 37% in 3.3–8.2 µm, and 10% in the >8.2 µm size fraction. Culture work is pending. Based on viral RNA loads, our results indicate that exhaled aerosols ≤3.2 µm contribute the majority of SARS-CoV-2 inhalation exposure. These data support the use of air cleaners and respirators that reduce inhalation of respirable aerosols as environmental and personal protective controls to mitigate COVID-19 transmission.

9ID.5

Effects of Portable Air Filtration Units on Submicrometer- and Micrometer-Sized Aerosol Particle Deposition and Concentration in a Natural Ventilated Skilled Nursing Facility.

LINHAO LI, Zachary Pope, Youngjoo Son, Stephanie Eilts, Christopher J. Hogan, Meng Kong, *Well Living Lab*

Older adults are the most vulnerable population to respiratory diseases (e.g., COVID-19, influenza). Identifying effective engineering controls is critical to reduce transmission risk via airborne particles, particularly in spaces where older adults reside (e.g., skilled nursing facilities; SNF). We therefore systematically investigated how recirculating portable air filtration (PAF) units, a common engineering control, and natural ventilation influenced airborne particle travel via the direct aerosol route (i.e., representing airborne transmission) and the indirect aerosol route (i.e., representing fomite transmission). A breathing simulator was built and used to atomize fluorescein-tagged submicrometer- (0.6-0.7 µm) and micrometer-sized (2 µm) particles simultaneously utilizing a physiologically correct inhalation-exhalation waveform, with the breathing simulator outlet connected to an anatomically correct respiratory manikin. Experiments were conducted in two SNF resident rooms, referred to as the 'infector' and the 'susceptible' rooms, with the former room containing the breathing simulator (i.e., proxy infected resident) and the latter room representing a susceptible resident's room. Observations revealed that despite PAF units enhancing deposition velocities for submicrometer- and micrometer-sized particles, effective deposition fluxes of submicrometer-sized particles were significantly lower during PAF use compared with the Baseline Condition. Further, PAF units increased the effective air exchange rate by ~3.7 and 4.5 times for submicrometer- and micrometer-sized particles, respectively, resulting in significantly lower particle concentrations (>60%) for these particle sizes versus the Baseline Condition. While natural ventilation significantly reduced submicrometer- and micrometer-sized particle concentration and deposition, evidence of cross-contamination between rooms was identified when natural ventilation was used as the singular ventilation solution. Taken together, observations validated our previous studies in that particle deposition is not negligible in smaller rooms with poor ventilation and that PAF units are recommended as a supplement to natural ventilation to best limit airborne particle concentration, and later particle deposition, in such indoor spaces.

9ID.6

Mysteriously Rapid Rise in Legionnaires' Disease Incidence Traced to Declining Sulfur Dioxide.

FANGQUN YU, Arshad Nair, Ursula Lauper, Gan Luo, Jason Herb, Matthew Morse, Braden Savage, Martin Zartarian, Shao Lin, *The State University of New York at Albany*

Legionnaires' disease (LD) is a severe form of pneumonia with a hospitalization rate of ~ 95% and a fatality rate of ~ 10–25% that is caused by multiple bacterial species of the Legionella genus. Legionella are found naturally in freshwater such as lakes and streams. The bacteria can become a health concern when they grow and spread in built water systems like cooling towers (CTs), hot tubs, decorative fountains, hot water tanks, showerheads, and sink faucets. Infection occurs when aerosolized Legionella are inhaled, or contaminated water is aspirated and bacteria enter the lungs. A recent dramatic increase in LD incidence has been observed globally, with a nine-fold increase in the US from 2000 to 2018, and with a disproportionately higher burden for socioeconomically vulnerable subgroups. Despite the focus of decades of research since the infamous 1976 outbreak, substantial knowledge gaps remain with regard to the source of exposure and the reason(s) for the dramatic increase in LD incidence. Here, we analyze reported LD case data along with air quality, meteorology, and cooling tower data. We rule out factors indicated in the literature to contribute to its long-term increases and identify a hitherto unexplored explanatory factor. We provide an epidemiological demonstration that the occurrence of LD is linked with exposure to cooling towers. Our results suggest that declining sulfur dioxide air pollution, which has many well-established health benefits, results in reduced acidity of aerosols emitted from cooling towers, which may prolong the survival duration of the Legionella in contaminated cooling tower droplets and contribute to the increase in LD incidence. Mechanistically associating decreasing aerosol acidity with this respiratory disease has implications for better understanding its transmission, predicting future risks, and informed design of preventive and interventional strategies that consider the complex impacts of continued sulfur dioxide changes.

9ID.7

Determination of Bipolar Ionization-Mediated Airborne Virus Inactivation Rates. DARRYL ANGEL, Jordan Peccia, *Yale University*

Reducing the concentration of infectious viral aerosols within indoor settings is essential for decreasing infectious risk. Common airborne virus concentration reduction approaches, including outdoor air ventilation, HVAC (heating, ventilation, and air conditioning) system filtration, and in-duct ultraviolet germicidal irradiation are limited by the air exchange rates that can be achieved in a building. Similar to drinking water treatment, directly disinfecting a building's bulk air with a non-toxic disinfectant is a more effective strategy for reducing airborne infection. Bipolar ionization (BPI) is a currently utilized building bulk-air disinfection technology with the potential to reduce airborne virus concentrations through two proposed mechanisms: facilitating particle agglomeration to increase virus deposition onto building surfaces, and loss of viral infectivity caused by ion-induced damage to viral surface proteins. We determined bipolar ionization-mediated first order inactivation rate coefficients for aerosolized bacteriophage Phi6, a common surrogate organism for SARS-CoV-2. At ~49% relative humidity (RH), the total (0.15 1/min to 0.22 1/min; $p<0.01$) and infectious (0.31 1/min to 0.50 1/min; $p<0.01$) Phi6 decay rate coefficients increased when average bipolar ion exposure was increased from a baseline of 10^3 ions/cm^3 to experimental conditions of 10^6 ions/cm^3. The same significant increase ($p<0.01$) in total and infectious Phi6 decay was present at high (~76%) RH in the presence of additional bipolar ions. While we observed no difference between total Phi6 decay rates at low (~26%) RH ($p>0.05$) between the two bipolar ion concentrations, the inactivation of infectious Phi6 owing to BPI remained significant ($p<0.05$) but lower than the values measured under middle and high RH. Across all RH levels, the inactivation of infectious Phi6 attributable to BPI was greater than the natural decay of Phi6.

9ID.8

Evaluating Particle Collection Efficiency in Exhaled Breath Condensate Using an Artificial Lung System. HAOXUAN CHEN, Airi Harui, Yu Feng, Michael D. Roth, Yifang Zhu, *University of California, Los Angeles*

The COVID-19 pandemic has renewed the interest in utilizing exhaled breath condensate (EBC) as a non-invasive sample for infection diagnosis and studying the virus-laden particles emitted through breathing. Current sampling methods prioritize condensation by rapidly cooling exhaled breath onto surfaces at very low temperatures to obtain maximal condensate volume. However, particle collection and related aerodynamics have long been overlooked. As a result, compared to reference samples (e.g., blood and urine), the low level and high variability of the analytes in EBC samples greatly impede its further application in clinical medicine.

To better understand particle collection efficiency and affecting factors in the EBC sampling process, we developed an artificial lung system that consists of a 6-L lung chamber fitted with a 3D-printed human airway structure. It can continuously breathe (i.e., inhale and exhale) with the temperature and humidity independently controlled to approximate human lungs. Additionally, the system integrates aerosolization of lung fluid surrogate, enabling exhalation of breath-borne particles to mimic human breath. We studied the particle collection efficiency of the RTube, a commonly used commercial EBC collector, in a 10-min simulated sampling process. Our results show a temperature-dependent curve for exhaled particle collection efficiency, with collection efficiency decreasing from 50% to 20% as the sampling temperature increases from -40 to -20 ℃. Ongoing studies will characterize the size-resolved particle collection curves under different sampling temperatures and examine whether implementing particle capture mechanisms such as impaction can enhance particle collection efficiency and thus improve the analyte levels in the EBC samples.

This study provides novel insights into the collection of exhaled particles during the EBC sampling process and generates valuable information for improving the EBC sampling method toward standardization for further clinical applications.

9ID.9

A Novel Approach for Short-Range Sampling of Respiratory Aerosols in Child Care Centers. ZHENYU MA, Peter Arts, Khalil Chedid, Aaron Prussin II, Andrew Hashikawa, Krista Wigginton, Adam Lauring, Linsey Marr, Emily Martin, Herek L. Clack, *University of Michigan*

MITIGATE FLU is a multi-site project that seeks to enhance our understanding of influenza transmission by integrating laboratory, animal, and human studies. The human study arm of the project focuses on preschool children to study the correlation between incidence of influenza infection and influenza virus concentrations in child care center environments (surfaces and air) in Michigan. To investigate short-range influenza virus exposure and transmission and to circumvent the challenges of implementing direct breath collection with small children, we have developed an innovative approach for detecting viral aerosols in exhaled breath. A 4" diameter induced draft (ID) fan located in an insulated case at a distance from the children is connected by a flexible hose to an intake vent located behind Moxie, an AI robot toy from Embodied (https://moxierobot.com/) that engages the children in conversation. The ID fan draft induces airflow around the robot sufficient to entrain exhaled respiratory aerosols. Gelatin filters mounted around the internal periphery of the fan housing served to collect a portion of the entrained respiratory aerosols. After sampling, the filters are then dissolved in an aqueous buffer for further analyses.

The method was validated by ultrasonically nebulizing bacteriophage MS2 at a distance of 5 inches in front of the robot, approximating a child’s position. After nebulizing 10 mL of MS2 in solution for 15 min, viable MS2 viruses were successfully retrieved from the gelatin filter, with an overall recovery rate of about 0.01‰. RT-ddPCR analysis for collected gene copies reveals a recovery rate of 0.03‰, higher than the recovery rate for viable phages due to phage inactivation after collection on the gelatine filters.

Our approach proposes a novel, less-intrusive method for short-range sampling of respiratory aerosols to identify the potential for airborne infectious virus exposure in child care center settings.

9ID.10

N95 Respirators Provide Superior Source Control for SARS-CoV-2. JIANYU LAI, Kristen K. Coleman, Sheldon Tai, Jennifer German, Filbert Hong, Barbara J. Albert, Yi Esparza, Aditya Kiran Srikakulapu, Petri Kalliomäki, Maria Schanz, Isabel Sierra Maldonado, Molly Oertel, Naja Fadul, Louie Gold, Kathleen McPhaul, Tianzhou Ma, Benjamin Cowling, Donald K. Milton, *School of Public Health, University of Maryland, College Pk*

BACKGROUND: SARS-CoV-2 is transmitted by infectious aerosols. Face masks reduce viral exhaled breath aerosols (EBA) released by infected persons. No human study has yet compared the efficacy of different masks and respirators as source controls. Here, we compared the efficacy of cloth masks, surgical masks, KN95, and N95 respirators as source control for SARS-CoV-2.

METHODS: From June 2020 to May 2022, volunteers infected with SARS-CoV-2 provided paired 30-minute EBA samples while masked and unmasked, using a Gesundheit-II sampler. Volunteers received no official training in the proper use of respirators. Our analysis included paired masked-unmasked same-day samples with detectable SARS-CoV-2 RNA. Aerosols were categorized by size: fine (≤5 µm) and coarse (>5 µm). Linear mixed effect models with censored responses were used to model the effect of masks on EBA viral RNA load, controlling for number of coughs during sampling and nested random effects of subjects.

RESULTS: Forty-four volunteers (3 Alpha, 2 Delta, 21 Omicron, and 18 Others) provided 60 same-day paired samples. All mask types significantly reduced the viral RNA load in both aerosol size fractions. N95 respirators reduced fine and coarse aerosol viral RNA by 98% (95% CI: 96% to 99%) and 99% (95% CI: 96% to 100%), respectively, and significantly outperformed face masks and KN95 respirators ($p<0.05$). We observed no significant difference among face masks and KN95 respirators.

CONCLUSIONS: Masks work as source control for SARS-CoV-2 and are appropriate for general community use to reduce transmission. N95 respirators are significantly more effective than all other types of masks even when used by untrained study participants. N95 respirators should be the standard of care in nursing homes and healthcare settings for both personal protection and source control when respiratory viral infections are prevalent in the community and healthcare associated transmission risk is elevated.

9ID.11

The Impact of Environmental Aging Processing on Bioaerosol Detection Using Circular Intensity Differential Scattering (CIDS).

DANIEL N. ACKERMAN, Yong-Le Pan, Kevin K. Crown, Ashley R. Ravnholdt, Elizabeth A. Klug, Joshua L. Santarpia, *National Strategic Research Institute*

Circular intensity differential scattering (CIDS) has recently been used to discriminate biological from non-biological particles in an aerosol based direct detection of nucleic acids in a single particle. Most sensors that can discriminate biological from non-biological are based on laser-induced fluorescence (LIF). Despite their continued use, recent studies have shown that LIF detection signatures are unstable under atmospheric conditions, complicating the interpretation of LIF sensor data. Since CIDS signals are based on the chirality of nucleic acids, environmental damage to nucleic acid is not likely to impact the CIDS return in the same way that it impacts the LIF signal. In order to test this hypothesis, MS2 aerosol particles were generated and exposed to both simulated sunlight and ozone in the Biological Aerosol Reaction Chamber (Bio-ARC). These rapidly aged particles will then be measured by a Wideband Integrated Bioaerosol Sensor (WIBS-4a), which measures aerosol fluorescence excited at 280 and 370 nm, and a novel aerosol measurement system that relies on CIDS. The impact of this simulated aging on both LIF returns and the CIDS returns will be evaluated. Since LIF and CIDS returns are likely to be impacted differently by environmental aging processes, this data will help inform the potential future uses of CIDS in the bioaerosol measurement applications.

9ID.12

The Detection of Respiratory Viruses in Heating, Ventilation, and Air Conditioning Units of University Buildings.

ZHOUYUAN WANG, Yangyang Zou, Irene Xagoraraki, Kaisen Lin, *Michigan State University*

Respiratory viruses, such as SARS-CoV-2 and influenza virus, are predominantly transmitted through the air and can cause human infections through inhalation. Therefore, it is imperative to closely and accurately monitor airborne respiratory viruses in indoor environments to protect public health. During the pandemic, numerous studies have reported detecting airborne SARS-CoV-2 in healthcare settings and quarantine rooms through active sampling. However, less effort has been made in surveilling other indoor spaces, such as commercial buildings and schools, where respiratory viruses may linger longer due to lower ventilation rates, leading to disease transmission. The goal of this study is to develop a novel approach to monitoring the outbreak and spread of respiratory diseases in public buildings. We collected 6 air filters from 3 heating, ventilation, and air conditioning units, including 3 MERV 8 pre-filters and 3 MERV 13 final filters, at Michigan State University's campus. These filters were installed in Nov 2022 and collected in Jan 2023. We recovered dust from air filters and extracted viral RNA from the dust. Qubit assays confirmed that viral RNA was successfully extracted from filter samples with as little as 50 mg dust with a concentration ranged from 0.74 to 12.31 µg RNA/ g dust. SARS-CoV-2 virus was detected on 4 out of 6 filter samples using droplet digital PCR. The concentrations were determined to be 753.30- 1829.57 genomic copies/ g dust. The results indicated the prevalence of airborne SARS-CoV-2 virus in lecture buildings on the university campus. It also demonstrated that HVAC systems can be used as a powerful sampling tool to monitor respiratory viruses. This approach will enable high temporal and spatial resolution sample collection, and results can supplement existing wastewater-based surveillance to monitor infection trends in communities.

9ID.13

Improving Industrial Air Quality: Modeling, Monitoring, and Use of Low-Cost Sensors. REN GARITY, Jianing Bao, Andrew Metcalf, *Clemson University*

While there are several techniques for quantifying indoor air quality using low-cost sensors, there can be a disconnect between the results from measurements and from full-scale fluid modeling that accurately predicts indoor air quality over a range of operating parameters. This disconnect is especially common in industrial environments. Although monitoring may be more prevalent here than in other indoor spaces, such as classrooms, the measurements are often focused on individual exposures rather than on understanding how the overall facility is performing, leading to gaps in understanding.

To bridge this gap, we propose an air quality modeling, monitoring, and sampling plan that we then implement at an industrial test facility. With the combined use of short-term, high-resolution sampling, modeling, and monitoring, there is a high chance of being able to create a ventilation plan that is adaptable to the needs of a changing industrial facility. For example, revisions can be made, and the model reevaluated, if machinery is moved or added or if ventilation capacity is changed.

In this talk, we discuss the feasibility of this verified modeling approach. We first compare data from a prior indoor air quality study in classrooms at Clemson University to results from NIST's CONTAM model. In the prior study, low-cost sensors were used to measure the spatial distribution of particulate matter. We discuss the challenges in reaching agreement between the measurements and the CONTAM model, owing to effects such as the accuracy of the low-cost sensors, ventilation rate, and filtration efficiency in the HVAC system. Finally, we expand our study to an industrial space, with new measurements and modeling to determine potential exposures to factory workers. Ultimately, this type of verified modeling approach will greatly benefit environmental, health, and safety professionals in the workplace who want to make data-driven decisions to protect workers' health.

9ID.14

Temporal Variation of SARS-CoV-2 Levels in Wastewater from a Meat Processing Plant. MEIYI ZHANG, Maria King, *Texas A&M University*

Wastewater-based surveillance (WBS) on SARS-CoV-2 has been proved to be an effective approach to estimate the prevalence of COVID-19 in communities and cities. However, its application was overlooked at smaller scale, such as a single facility. Meat processing plants are hotspots for COVID-19 outbreaks due to their unique environment that are favorable for the survival and persistence of SARS-CoV-2. The viruses in the wastewater originate from the air and surfaces in the facilities, as pathogens are continuously resuspended into bioaerosols and washed into the wastewater tank through hosing during daily operations. This is the first known WBS study in meat processing plants. The goal was to understand the temporal variation of the SARS-CoV-2 levels in wastewater from a meat processing plant in Canada during a three-month campaign and to find any correlation with clinically confirmed cases in the surrounding city area. Higher SARS-CoV-2 concentrations and detection frequencies were observed in the solid fraction compared to the liquid fraction of the wastewater. The viruses can be preserved in the solid fraction of wastewater for up to 12 days. The wastewater virus level did not correlate to the city-wide COVID-19 cases due to the unmatching scales. WBS on SARS-CoV-2 in meat processing plants can be useful for identifying COVID-19 outbreaks in the facility and serve as an effective alternative when resources for routine individual testing are not available.

9ID.15

Binding Behaviors of SARS-CoV-2 Virus and Ivermectin. Kasidy Gossen, MEIYI ZHANG, Brooke Smith, Maria King, *Texas A&M University*

The COVID-19 pandemic, caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), sparked an international debate on the best ways to prevent and treat the virus. Specifically, there were many varying opinions on the use of ivermectin throughout the world, with minimal research to support either side. Ivermectin is an FDA-approved anti-parasitic drug that was discovered in the 1970s and was found to show anti-viral activity. The objective of this study was to examine the binding behavior and rate of association between SARS-CoV-2 receptor binding domain (RBD), ivermectin, and their combination using aminopropyl silane (APS) biosensors as surrogates for hydrophobic ACE receptors to determine the potential of ivermectin as a repurposed drug for SARS-CoV-2 prevention and treatment. The ivermectin binding kinetics were analyzed using biolayer interferometry (BLI), a label-free technology, and validated with molecular dynamics simulation. Our results show that with increasing ivermectin concentration the association rate with the hydrophobic surface increases with a simultaneous decrease in dissociation. Significant kinetic changes to RBD, when combined with ivermectin, were found only at thousand times the approved dosage. Our study suggests that ivermectin is not an effective preventative or treatment method at the currently approved dosage.

9ID.16

Modifying CDC Manikin Fit Evaluation Method to Match Fit Testing with Human Subjects. ALI HASANI, Joseph Dawson, Magdalene Fogarasi, Kirstie Snodderly, Dana Rottach, Daniel Porter, Suvajyoti Guha, *Center for Devices and Radiological Health, US FDA*

During COVID-19 pandemic N95 respirators offered a first line of defense for the healthcare workers against SARS-CoV-2. Although most typical N95 respirators are indicated for one-time use, significant shortage of these respirators led the healthcare workers to either use the respirators repeatedly or decontaminate and reuse them, resulting in many donnings. The three most important metrics for a respirator to offer protection to the wearer is its fit, filtration efficiency and breathability. While filtration efficiency and breathability can be measured using *in vitro* test methods, fit requires testing on human subjects. During COVID-19 pandemic, because of logistical challenges, a manikin fit test method from CDC's NIOSH was proposed as an alternative to fit testing with human subjects and was often used. A manikin fit test method poses an advantage over actual fit testing as its not as resource intensive and does not pose a logistical challenge to implement. However, subsequently, it was determined that the manikin fit testing method is not as sensitive in predicting fit failure rates as tests performed on human subjects. In this presentation the authors will revisit the CDC's manikin fit evaluation method, make simple changes to it and demonstrate how the changes made can result in the manikin method to show excellent agreement with the real world fit-testing results obtained with human subjects. Different examples will be provided with repeated donning and doffings, and decontamination methods (e.g. autoclaving and moist microwave generated heat).

9ID.17

A Retrospective Analysis of the Technological Characteristics of Pediatric Facemasks Marketed within U.S. Ali Hasani, Bryan Ibarra, Magdalene Fogarasi, Kirstie Snodderly, Dana Rottach, Daniel Porter, SUVAJYOTI GUHA, *Center for Devices and Radiological Health, US FDA*

Pediatric facemasks, like N95 respirators, are intended to provide some degree of respiratory protection. However, the technological characteristics for pediatric masks are different from that of adult N95 respirators because of the lower breathing resistance needed, the higher risk of asphyxiation, misuse, or injury, and because the pediatric facemasks need to be appropriate for smaller faces. While N95 respirators have been heavily characterized, pediatric facemasks have received little attention. Given the universal need for respiratory protection during COVID-19 pandemic, this field requires more research. Like respirators, filtration efficiency, breathability and fit-tests using anthropometric studies of pediatric facemasks are extremely important attributes. To date very little research has been performed that has compared the filtration efficiency, pressure drop and fit testing across multiple legally marketed pediatric facemask brands. In this presentation we will characterize the filtration efficiency, and breathability of four brands of pediatric facemasks that are currently marketed in the U.S. using *in vitro* testing. We will also assess the adequacy and appropriateness of current test methods that medical device manufacturers use to characterize pediatric facemasks.

9ID.18

Variations In HVAC System Fresh Air Exchange Among Child Care Centers. HEREK L. CLACK, Khalil Chedid, Andrew Hashikawa, Krista Wigginton, Adam Lauring, Linsey Marr, Emily Martin, *University of Michigan*

MITIGATE FLU is a multi-site project that seeks improved understanding of influenza transmission through integrated laboratory, animal, and human studies. The human study arm seeks to correlate incidence of influenza infection in child care attendees to influenza concentrations found in the environment (surfaces and air) of child care centers in our local region. Child care centers vary greatly in their design and operation, making it difficult to develop comprehensive guidance for reducing the risk of airborne transmission of influenza and other infectious diseases. During the early stages of the COVID-19 pandemic, general guidance from public health agencies suggested maximizing HVAC system fans to increase the number of air changes per hour (ACHs) and thereby more rapidly flush airborne pathogens from indoor spaces. However, within child care centers enrolled in the MITIGATE FLU project, HVAC system layout varied substantially; notably, several centers were designed with adjacent classrooms sharing a thermostat and an HVAC unit. To explore the implications of these varied HVAC configurations, we used CO2 tracer decay in adjacent classrooms at several child care centers to experimentally measure actual ACHs. The results revealed that adjacent classrooms that share a thermostat and HVAC unit experience varying degrees of air recirculation, greater than 70% to less than 25%. For cases where air recirculation is high, operating HVAC systems more intensively has the potential to facilitate greater airborne pathogen transmission between classrooms, depending on the quality of HVAC filter installed. Our results underscore the need for a nuanced approach to reducing airborne disease spread in child care centers. An effective strategy likely requires detailed consideration of the center layout, HVAC system operation, and filtration strategy that is tailored to each site, rather than generalized guidance based on a simplified geometry and assumptions.

9ID.19

Wearable Air Curtains as Advanced Personal Respiratory Protection. Samuel Sugarman, E.L. Pfeiffer, HEREK CLACK, *Taza Aya, Inc.*

Although face masks reduce the airborne spread of disease, the COVID-19 pandemic plainly demonstrated their numerous shortcomings as viewed by the general public, including breathing discomfort, diminished protection for children and those with facial hair, and interference with eating and drinking. Although face mask use has diminished along with the risk of severe COVID for many, millions of people remain at risk due to compromised immune response or comorbidities and face either continued social isolation or continued face mask use.

Air curtains are routinely used in buildings to maintain environmental separation between spaces. Taza Aya is developing a miniaturized, wearable air curtain - essentially mask-less personal respiratory protection - that avoids the limitations and discomfort of conventional face masks. To demonstrate the efficacy of wearable air curtains, aerosol challenge tests were conducted in a 2’ x 6’ x 2’ wind tunnel. A 3D-printed visor was mounted in the wind tunnel, custom designed with an array of air nozzles distributed along its brim. PM_{10} aerosols were generated upstream of the mounted visor using either an ultrasonic nebulizer or a glycerol-based theatrical fog generator. Results show baseline PM_{10} exclusion performance of > 95% for air curtain air flow rates up to 3 scfm, superior to most of the 11 common face coverings and face masks of a variety of materials reported by Pan et al. (2021). While N95/KN95 masks undoubtedly provide the highest level of protection, such protection is only assured with routine fit testing of an individual and their mask, an unworkable requirement for the general public. Wearable air curtains offer the potential for personal respiratory protection without the need for fit testing and without the inconveniences of traditional face masks.

9IM.1

Using Atomized NaI Particles as a Counting Efficiency Booster for Partial Calibration of Periodic Technical Inspection Reference Particle Counters. Helmut Krasa, Martin Kupper, Mario Anton Schriefl, ALEXANDER BERGMANN, *Graz University of Technology*

In the second half of 2023, Germany will introduce PN emission measurements as part of the Periodic Technical Inspection (PTI) for passenger cars, which will require every EURO 6 homologized car to have its particle number (PN) emissions assessed with the PTI [1]. Thus, a large number of PN counters will be in use and a fast and simple calibration method is required. Condensation particle counters (CPCs) fulfill the PTI counting efficiency (CE) limits and are well-established devices for homologation measurements. Therefore, these devices often may be used as reference instruments for in-field PTI PN counters. In this work, we present an in-field calibration of the linearity and plateau CE for PTI reference counters using atomized NaI.

Particle generation with an atomizer allows for compact and energy-efficient generation of nanometer-sized salt particles. We use atomized NaI and show that is detected down to 18 nm with >90% CE for homologation CPCs, which have their adjusted cut-off size at 23 nm [2]. The CE is also evaluated for different salts for comparison.

The mean diameter of the NaI particle size distribution correlates with the salt concentration in the solution. At 1.2 w% NaI, a mean diameter of 46.8 nm and standard deviation of 1.7 was obtained [2]. Due to the higher CE of NaI compared to other particles, the reduction in CE of polydisperse particles compared to monodisperse particles in the plateau region was less than 1%. Measurements for particle concentrations between 80 and 30 000 cm^2 showed excellent linearity, with an $R^2 > 0.99$.

With NaI the plateau CE and the linearity can be calibrated without the use of a differential mobility analyzer, using only a portable atomizer, compressed air and a reference counter, enabling partial in-field calibration.

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9IM.2

Measuring the Charger Efficiency in the Electrical Low Pressure Impactor for Fractal Aggregates Using an Aerodynamic Aerosol Classifier. Nishan Sapkota, Timothy Sipkens, MANG GUAN, Anand Kumar, Steven Rogak, *University of British Columbia*

The Electrical Low-Pressure Impactor (ELPI) provides a route to rapidly characterize the aerodynamic diameter of particles. However, its operating principle involves unipolar charging of the aerosol. The charging efficiency of this unipolar charger is defined as a power-law function of electrical mobility diameter and is well known for spherical particles. However, for low density fractal aggregates, such as soot, the charging-equivalent diameter is larger than the mobility diameter and much larger than the aerodynamic diameter, complicating analysis. Previous attempts to address this issue involved measuring charging efficiency using mobility-classified particles.

The recent introduction of the Aerodynamic Aerosol Classifier (AAC) has provided another route to characterize the aerodynamic diameter of the particles that avoids the effects of multiply-charged particles at the cost of response time. Here, we use the AAC to determine the charging efficiency in the ELPI. Combining this arrangement with a Scanning Mobility Particle Spectrometer (SMPS), this setup can be used to measure the charging behavior as a function of both the aerodynamic and mobility diameters. Further, this setup allows for the transfer of the accuracy of the AAC to a rapid response instrument in the ELPI, which can then be used for accurate, real time measurement of soot. Results of the method are presented for both spherical particles and soot from an Argonaut inverted burner.

9IM.3

Intercomparison of Instrumental Methods Using Model II Regression. COLLEEN MARCIEL ROSALES, Nicholas E. Brunk, Nicole Hyslop, Nicholas Spada, *University of California, Davis*

X-Ray fluorescence spectroscopy (XRF) and Inductively Coupled Mass Spectroscopy (ICP-MS) are both experimental techniques for the elemental characterization of particulate matter (PM). The reproducibility of estimations of sample elemental composition between the two techniques is not well understood. Using data collected from an ambient monitoring network, we have compared measurements using both techniques on the same samples, specifically assessing the elemental composition by quantifying concentrations of 29 elements in 549 samples using both techniques. Instrumental intercomparison was quantified via the use of Model II statistical regression techniques that, unlike OLS regression, account for experimental error in both variates without the asymmetry of choosing a given reference instrument.

9IM.4

Recommendations for Improving Aerosol Measurement in India. SATOSHI TAKAHAMA, Arindam Roy, Athanasios Nenes, *LAPI, EPFL (Switzerland)*

Heterogeneous source distribution and mixed land-use patterns have made India and other countries in the global south distinctive compared to the countries of the Global North. The Indian air quality guideline is directly adapted from the air quality monitoring guidelines from US/Europe. We have evaluated the monitoring guideline and conducted a series of field visits to identify the gap area. We have observed several deviations from the present guidelines, such as; insignificant numbers of rural stations, absence of meteorological measurements in offline stations, and measurement of multiple pollutants over the same stations. We strongly recommend primarily focusing on PM2.5 measurement rather than measuring 10 pollutants together.

Our observations suggest that mixed land use and rapid urban growth often reduce the spatial representativeness of the monitoring sites. Due to the mixed land use, true residential, commercial, or industrial areas are not present in Indian cities. An overlap of these land-uses types is often observed. We are recommending modifying the current guideline and addressing this particular challenge. We have proposed a classification scheme at the micro level according to the source, land use and population for classifying existing sites and selecting locations of future areas. We also recommend documenting site metadata for present monitoring stations and using different proxy datasets (nighttime light, satellite-derived PM2.5) for selecting future monitoring sites.

9IM.5

Laboratory Evaluation of the Alphasense Opc-N3, and the Plantower PMS5003 and PMS6003 Sensors. KAMALJEET KAUR, Kerry Kelly, *University of Utah*

Numerous studies link adverse human health effects to ambient levels of particulate matter (PM), although fewer studies have evaluated the health effects of coarse PM (diameter larger than 2.5 µm). Coarse PM measurements are also scarcer than PM2.5 measurements. Low-cost PM sensors, such as the Plantower PMS5003, have been used complement regulatory measurements to provide highly resolved estimates of PM2.5 concentration. However, most low-cost PM sensors are ineffective at measuring coarse PM. In contrast, the Alphasense OPCs have shown promise in detecting coarse PM and have been used in the field to measure PM10 concentrations. Despite field evaluations being critical for understanding sensor performance under environmentally relevant conditions, they provide limited information about sensor response characteristics, which are essential for determining factors that may affect sensor measurements and contribute to inter-sensor variability. This study aims to systematically evaluate the response of the Alphasense OPC-N3, and the Plantower PMS 5003 and 6003 to monodisperse particles of various diameters generated by a flow-focusing monodisperse aerosol generator and compared to an aerodynamic particle sizer (APS). The study evaluated nine different OPCs, three PMS5003s, and four 6003s. The Plantower PMS 5003s and PMS 6003s detected all particle sizes but assigned all particles to the smallest size bin. The OPC-N3s detected all particle sizes and exhibited a coefficient of variance of less than 10% compared to the APS, although they tended to overestimate particle diameter slightly. The OPCs generally underestimated particle concentration compared to the APS (bias between 7 to -75%) and inter-sensor variability that increased with particle diameter (19.4% for 2 µm and 34.2% for 10 µm). The OPC-N3 laser wavelength varied between 600-650 nm, and this variation was correlated with inter-sensor variability of the mean diameter measurements, while the flow rate reported by the OPC affected the inter-sensor variability in the number concentration.

9IM.6

Investigating Efficient Flight Pathways with Continuous and Discrete Sampling for UAV-based Greenhouse Gas Monitoring at Environmental Infrastructures.

HORIM KIM, Keun Taek Kim, Hyeri Jo, Minyong Yang, Young Su Lee, Sangjae Jeong, Jae Young Kim, *Seoul National University*

Greenhouse gas emissions from environmental infrastructures represent a significant source of anthropogenic air pollution, demanding efficient monitoring strategies. Conventional monitoring methods often struggle to capture the spatial variability and real-time changes in emissions. Unmanned aerial vehicles (UAVs) offer a promising solution to this challenge. Well-designed flight pathways and sampling strategies are essential for UAV-based greenhouse gas monitoring, as they improve data accuracy and efficiency within the constraints of limited flight time and resources. The present study investigates suitable flight pathways and sampling strategies for UAVs, examining two UAV flight methodologies: (1) continuous sampling without hovering flight, and (2) discrete sampling with hovering flight, analyzing potential benefits and drawbacks of each approach concerning the quality of data collection and time efficiency. Initial findings suggest that the continuous sampling method can extend the length of flight pathways; however, the sensor accuracy can be hindered by propeller-induced wind. Implementing flight operation criteria in the continuous sampling can help to alleviate the adverse impact on the sensor system. In comparison, hovering flight is widely recognized for enabling consistent data collection at specific locations, facilitating precise measurements in areas with complex emission sources. Furthermore, we explore flight pathways for two emission source types, point and area sources, incorporating various measurement approaches such as downwind plume measurement and plume transect measurement assuming the Gaussian plume model. Two targeted environmental infrastructures are solid waste incinerator (point source) and a landfilling site (area source). Preliminary experiments demonstrate that customizing flight pathways based on the specific source type can lead to more efficient greenhouse gas monitoring. Identifying effective flight pathways for each source type can contribute to more efficient utilization of UAVs for understanding the emission characteristics of environmental infrastructures.

9IM.8

Smoke Impacts on Atmospheric Processing: An Optical Analysis of Broadband Offline and Online Instruments on Geographically Diverse Biofuels.

NEVIL FRANCO, Abu Sayeed Md Shawon, Megan Mouton, Vaios Moschos, Marc Fiddler, Solomon Bililign, Manvendra Dubey, Katherine Benedict, Kyle Gorkowski, *Los Alamos National Laboratory*

To enhance our understanding of biomass burning aerosol on climate, we analyzed the optical properties–absorption, extinction, and scattering–of vegetation from distinct geographical origins using wavelength-dependent instruments in both field and laboratory settings. This approach aims to shed light on the complex interactions between biomass burning and changes to the optical properties.

Controlled burns of sub-Saharan African biofuels were conducted at Los Alamos National Laboratory in collaboration with North Carolina A&T State University as part of the African Combustion Aerosol Collaborative Intercomparison Analysis (ACACIA) project. The online instruments were a mini-aethalometer (MA200), dual-spot aethalometer (AE33), cavity attenuated phase shift single-scattering albedo particle monitor (CAPS PMssa), and a photoacoustic spectrometer (PASS and PAX). Offline collection used a Particle-Into-Liquid Sampler for wavelength-dependent analysis using a Liquid Waveguide Capillary Cell (LWCC) and a thin-film Reflectometer (F10-RT). The F10-RT captures the transmitted and reflected spectra of the aerosols across a wide wavelength range (190 to 1100 nm).

For comparison to the lab experiments, field data were taken from prescribed fires of prairie tallgrass at the Konza Prairie Biological Station located near Manhattan, Kansas. A mini-aethalometer (MA200) was used to capture the optical properties of smoke plumes.

Taken together, this work establishes analysis techniques for examining changes in aerosol optical properties during future cloud cycling experiments.

9IM.9

Fast Characterization of Irregularly Shaped Particles Using Elastic Light Scattering. AIMABLE KALUME, Jessica Arnold, Chuji Wang, Gorden Videen, Yong-Le Pan, *U.S. Army Research Laboratory*

Elastic light scattering (ELS) is a non-invasive diagnostic technique widely used to characterize small particles, capable of retrieving highly accurate information (size, shape, surface roughness, refractive index, etc.) for spherically shaped particles. However, this practice has had limited application for irregularly shaped particles due to the angular dependence of the scattered light intensity, resulting in an unlimited number of possible scattering patterns for a single particle. Working with synthetic data of ELS patterns, we demonstrated that machine-learning algorithms can classify different irregularly shaped particles fast and with great accuracy (up to 97%). To apply this method toward real world problems, experimental light-scattering patterns of various particles need to be collected. Through our recent works, we presented a novel method for actively controlling circular and/or spin rotational motion of optically trapped airborne particles, by manipulating the trapping laser beam using a cylindrical lens. We demonstrated a method for recording 2D forward-scattering patterns from optically trapped single airborne particles at multiple angular orientations, for a wide range of particle morphologies, paving the way towards the development of a fast characterization technique for irregularly shaped atmospheric particles, by combining ELS experimental data with machine-learning algorithms.

9IM.10

Demonstration of the New Aethalometer Model AE36s Performance and Equivalence with Its Predecessor, AE33. MARTIN RIGLER, Gašper Lavrič, Matic Ivančič, Viktor Pilko, Bálint Alföldy, Irena Ježek Brecelj, Asta Gregorič, *Aerosol d.o.o.*

The Aethalometer is a widely used filter photometer capable of measuring the light-absorbing properties of aerosol particles. In this study, we present the performance of the new Aethalometer model AE36s (Aerosol Magee Scientific) and show equivalence with its predecessor AE33. The new model addresses two crucial areas that have emerged in the scientific community in recent years: (1) the sensitivity of filter photometers to rapid changes of relative humidity, (2) the need for improved characterization of the absorbing part of organic aerosols in blue and UV region, the so-called brown carbon (BrC). Despite technical changes and improvements of the instrument, continuity of data of absorption measurements is essential; thus, in this study, we demonstrate the equivalence with AE33 through a series of laboratory and ambient measurement campaigns.

Aerosol samples contain water vapor (represented by its relative humidity, RH), which can be adsorbed to the fibers or to the binding material of the filter tape used in filter photometers. It has been shown that rapid changes in humidity (dRH/dt), rather than absolute humidity itself, have a significant effect on the measurements made with the filter photometers. Water vapor can reach the filter through the sample inlet or enter through openings in the filter tape compartment, especially in environments where relative humidity changes rapidly (air-conditioned containers, mobile stations, etc.) While the RH changes in sample air are adequately decreased with a Sample Stream Drier (Aerosol Magee scientific), the problem of rapid RH changes in the vicinity of the filter tape is solved in the new Aethalometer model by air sealing the filter compartment. In this study, the AE36s was subjected to various tests, sampling particle-free air with stable RH, whereas the humidity in the surroundings of the instrument changed rapidly, simulating the fluctuation of RH introduced by air-conditioning.

Additionally, to improve the characterization of BrC share of absorption in blue and UV regions, two additional wavelengths were introduced in the new Aethalometer model AE36s with respect to the older models: the 400 nm increases the resolution of absorption in a large gap of AE33 channels between 370 nm and 470 nm, and 340 nm extends the measurement range in the UV spectrum.

The performance of AE36s with improvements mentioned above was evaluated and compared to its predecessor AE33 during a long-term field campaign at an urban background site in Ljubljana, Slovenia (winter-spring 2022 and winter 2023), and laboratory tests with an artificial soot generator. Slopes of the orthogonal regression for all common wavelengths are within 5% range relative to the unity with $R2 > 0.99$. Signal to noise ratio in the AE36s is also significantly improved, which results in more stable determination of the absorption Ångström exponent.

9IM.12

Multi-Wavelength Multi-Angle Technique and Next Generation Particle Sensor: An Approach for Particle Characterization. SHRUTI CHOUDHARY, Tandeep Chadha, Jiaxi Fang, Marit Meyer, Paul Mudgett, Pratim Biswas, *University of Miami*

Compact devices that can measure particle size distribution, shape, and composition are being developed to provide real-time information of exposure to particulate matter. Applications are related to public health improvement (spread of pandemics), human missions to space, and industrial and occupational hygiene [1, 2, 3]. We propose modifying the design of compact particulate matter sensors to provide additional information on the composition of the particles by utilizing a multi-wavelength, multi-angle (MWMA) technique. This device will have the capability of real-time classification of particles based on size and refractive index utilizing light scattering theories for data inversion [4]. Three different wavelength light sources and a rotating detector are used to obtain the scattering patterns, and then establish the size and refractive index of the particles. We will demonstrate the calibration of this system with a variety of test aerosols.

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9IM.13

Capturing Single Aerosol Particle-Droplets into a Microfluidic Device for Surface-Enhanced Raman Spectroscopic Analysis. WENDY FLORES-BRITO, Shelley Anna, Coty Jen, Ryan Sullivan, *Carnegie Mellon University*

Individual physicochemical analysis of individual aerosol particles continues to be a challenge since few techniques that can preserve an aerosol's individual identity while transferring the particle for further offline analysis exist. Here, we build upon a method developed in our group that features direct activation of aerosol particles into droplets by water 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 compare the use of a different growth column (Sequential Spot Sampler) from the original method (Cloud Condensation Nuclei Counter), which should prevent condensation-produced droplets from entering the microfluidic device and provide an increased homogeneity in size droplet production using a smaller temperature gradient. The condensational growth column technique used by the spot sampler also allows for a wider range of applications such as the study of volatile particles and collection of viable bioaerosol. To evaluate the experimental method, we collected single-particle-droplets containing fluorescent salt into the open channel of the microfluidic device with oil flowing through it. The success of different surfactants at preventing droplet coalescence following oil capture was evaluated. The droplet capture efficiency was evaluated as a function of microdroplet size using fluorescence microscopy. Additionally, we present our initial work towards combining this aerosol particle microfluidic capture technique with online real–time chemical analysis using Surface-Enhanced Raman Spectroscopy (SERS). The combination of these methods will create a promising technique for the sampling and real–time field analysis of single aerosol particles using small microfluidic devices.

9IM.14

Challenges in Measurement and Interpretation of the Lidar-retrieved Aerosol Vertical Turbulent Mass Fluxes. NICHOLAS MESKHIDZE, Ajmal Rasheeda Satheesh, Markus Petters, *NC State University*

Vertical turbulent mass fluxes of particles measured using tall masts and balloon measurements have been used to study the tight coupling between aerosol microphysics and convection. Although such measurements have proven to be valuable for particle concentration and surface-layer meteorological research, mast measurements often raise the issue of representativeness for the broader region of interest (limited spatial extent) while balloons get deployed over shorter periods (limited temporal scope). Active remote sensing can overcome some of the shortcomings of mast and balloon measurements. Active sensors such as lidars and radars can retrieve information on vertical velocity, aerosol extinction and backscatter, linear depolarization ratio, backscatter color ratio, etc. with a spatial and temporal resolution required for the flux measurement. However, interpreting aerosol turbulent fluxes in the atmosphere is challenging as it requires accurate and comprehensive characterization of the boundary layer structure, aerosols, mixing mechanisms, clouds, and vertical profiles of humidity. In this study, using the data collected at the DOE Atmospheric Radiation Measurement Southern Great Plains site in Oklahoma in 2020, we discuss some of the difficulties and offer potential solutions for the interpretation of aerosol vertical turbulent mass fluxes retrieved using Doppler lidar and high spectral resolution lidar. The topics discussed are statistical stationarity, horizontal homogeneity, and ergodicity of the aerosol field (i.e., the fundamental principles of Reynolds decomposition), identification of convective turbulent regions in the boundary layer, eddy covariance and relaxed eddy accumulation techniques of flux measurement, conversion of attenuated backscatter to backscatter and the effect of relative humidity on the aerosol lidar ratio, systematic and random uncertainties (e.g., the integral time scale of turbulence and the instrument level of detection), the frequency response of the instrument and the flux averaging time. We hope our presentation will spark a discussion on potential limitations and best practices of remote sensing applications for aerosol mass flux retrievals.

9IM.15

Effect of the Uncertainty in Density of Polystyrene Latex (PSL) Spheres on the Calibration of Aerosol Instruments. JULIE PONGETTI, Chris Nickolaus, Jonathan Symonds, *Cambustion Ltd*

Calibrated polystyrene latex (PSL) nano- and microspheres are commonly used by both manufacturers and users to check the accuracy and precision of aerosol sizing instruments. This has worked well traditionally for instruments that use electrical mobility or light scattering as a measurement principle, but there is now an increasing trend towards the use of alternative sizing metrics (e.g., mass, aerodynamic diameter) in the aerosol community.

When calibrated PSL spheres are used as a reference for instruments measuring mass and aerodynamic diameter, the density of the material must also be known along with the particle size to calculate the metric of interest. However, most PSL manufacturers only certify the particle diameter, and the quoted density is that of the bulk material.

This work further investigates the typical variations in the density of PSL particles, which have previously been reported to be of the order of 1-2% above the bulk material density of 1.05 g/cm3 (Ehara et al, 2006). This has implications in the context of instrument calibration and accuracy verification, and the expected uncertainties need to be revisited in this light. For mass-based instruments, the “calibrated” mass which can be obtained using PSL particles shows large uncertainties due to the combined effect of diameter cubed and density; while the influence of density is stronger for instruments based on aerodynamic diameter due to the linear dependency on the particle size.

The relative effect of the uncertainty in the density of PSL opens the question of whether different methods should be preferred for routine testing of instruments measuring something other than mobility diameter. As an example, DMA-classified droplets of a low-volatility liquid are used to test an Aerodynamic Aerosol Classifier (AAC) and the achieved uncertainty in aerodynamic diameter is compared to that of calibrated PSL particles.

9IM.16

Aerosol Sensor Based on Air-gap Fabry-Perot Optical Microcavities. Chandra Raman, JACOB WILLIAMSON, Spencer Olson, Meagan Plummer, Robert Leonard, Matthew Marshall, *Georgia Institute of Technology*

Optical technologies are enabling a variety of molecular and particle sensing applications. One emerging sensor type is the chip-scale planar whispering gallery mode (WGM) resonator [1], where the primary sensing mode involves changes in optical transmission when an aerosol particle adheres to or passes very close to the surface. However, a key limitation of WGMs is that as surface sensors, they do not directly probe particulate matter that is freely diffusing in air. Moreover, particle adhesion is often irreversible and causes sensor degradation. In this work, we present an alternative, non-perturbative sensor architecture based on high-finesse Fabry-Perot optical microcavities with a macroscopic air gap. The gap allows small particles to flow through the cavity volume without adhering to optical quality surfaces, thus allowing for long-lived and robust sensors that can enable long term field applications in aerosol detection. Beyond the PM10 and PM2.5 particulate matter standards, we are also exploring the potential use of this technology for sensing of ultrafine particles. Our results are promising for the realization of laboratory quality particle detection in portable devices for personal and environmental health monitoring.

[1] Xuefeng Jiang, et al, “Whispering-Gallery Sensors” (Review), Matter 3, 371–392, August 5, 2020.

9IM.17

Performance Characterization of an Aircraft Inlet for Aerosol-Gas Sampling. DA YANG, Rainer Volkamer, Lee Mauldin, Margarita Reza, Suresh Dhaniyala, *University of Colorado Boulder*

Aircraft-based measurements allow for large spatial-scale characterization of atmospheric aerosol and gas, but these measurements, under high-speed flow conditions, complicate efforts to maintain sample integrity through the inlet transport process. Of particular concern is the role of turbulence in driving loss of gas-phase species and aerosol particles. While a significant amount of research has gone into understanding aerosol sampling efficiency for aircraft inlets, a similar research investment has not been made for gas sampling. Here, we analyze the performance of a front-facing inlet as a function of operating conditions, including ambient pressure, freestream velocities, and sampling conditions. Using computational fluid dynamics (CFD) modeling, we simulate flow inside and outside the inlet to determine the extent of freestream turbulent interaction with the sample flow and its implication for gas and aerosol sample transport. The CFD results of flow features in the inlet are compared against high-speed wind-tunnel experiment results of average internal flow velocities, turbulence intensities, and gas transport losses. These comparisons provide critical validation of the reliability of turbulent models and support further validation of different designs. We will present the results of CFD simulations and wind-tunnel validation tests, and discuss implications for aircraft based gas-aerosol sampling.

9IM.18

Aspiration Efficiency of Purpleair Pa -2- Flex Air Quality Sensor under Varying Wind Conditions. NAGARAJAN RADHAKRISHNAN, Suresh Dhaniyala, *Clarkson university*

Low cost sensors such as Plantower's PMS5003, have revolutionized the availability of air quality data at high spatial resolution. For ambient measurements, these sensors are housed in a variety of enclosures and located in open spaces. The sensors report mass concentrations of particles in different size ranges such as PM1, PM2.5, and PM10. While there is an increasing understanding of the sensors' detection efficiency as a function of particle size, there is less understanding of the role of enclosure design in modulating the concentrations of particles available for detection by the sensors. In this study we evaluate the aspiration efficiency of the purple air sensor using computational fluid dynamics (CFD) simulations. We generated a 3D model of the Purpleair PA-2-Flex sensor housing and used k-ε and SST k-omega turbulence models to simulate the flow field around the unit. The aspiration efficiency of the sensor was then calculated for 5 different freestream velocities, with and without the effect of turbulence using the ANSYS Fluent and particle discrete random walk (DRW) models. The interaction of particles with the complex flow fields entering the purple air enclosure are not captured with existing sampling empirical correlation such as Hangal and Willeke (1990). We will present the CFD results and comparisons of the predictions against existing correlations. Analysis of field data to validate the calculations will also be presented.

Keywords: Low-cost air quality sensor, Aspiration efficiency, Deposition velocity, Urban air quality monitoring.

9IM.19

Long-Term Performance of Low-Cost PM2.5 Sensor Calibration Utilizing Denver's Love My Air Network. TEHYA STOCKMAN, Shelly L. Miller, *University of Colorado Boulder*

Denver, Colorado is operating a network of over 30 low-cost PM2.5 sensors (Plantower, Lunar Outpost, and Clarity Movement Co.), with the oldest sensors brought online in 2018. While sensor networks are growing in popularity and many corrections have been developed for low-cost PM2.5 sensors, there is a gap in understanding how these low-cost sensors and corrections perform over multiple years. Most studies developing sensor corrections are less than one year in length. Denver's network, which includes eight co-located sensors at six federal equivalent monitoring sites since 2018/2019, presents an opportunity to evaluate performance over multiple years. We evaluated sensor bias and variability over time and across sensor manufacturers. We also developed and evaluated corrections for the sensor network using multi-linear regression and machine learning models. We considered models that included variables for meteorology, smoke events, dust events, and sensor age.

9IM.20

Combining Low-cost Air Quality Sensors with a Micronet for Fine-scale Monitoring in NYC. Ellie Hojeily, JANIE SCHWAB, Jason Covert, Kit Moore, Matthew Brooking, Sarah Lu, Md. Aynul Bari, Scott Miller, *University at Albany, SUNY*

The New York City Metropolitan Area includes 37 sites that are part of two meteorological networks continuously monitoring weather-related parameters: the New York State Mesonet (NYSM, established 2017), and the New York City Micronet (NYCM, established 2020). Both networks were installed and are maintained by the NYSM which is based at the University at Albany. We designed and built low-cost air quality sensor packages to measure particulate matter (PM2.5), carbon monoxide, ozone, nitrogen dioxide, and nitrogen monoxide at these sites. The stand-alone packages are mounted to NYSM and NYCM towers at roughly 2 m above the surface, and utilize NYSM power and communications infrastructure. The air quality sensors are sampled every 5 seconds and data are retrieved hourly by NYSM servers. Prior to deployment at field sites, the packages were co-located with NYS Department of Environmental Conservation reference-grade instruments at Queens College in NYC for one month. Data during the co-location period were used to develop calibration models. Deployment at 21 NYSM sites and 16 NYCM sites is expected to be completed in summer 2023. The sensor calibration approach and performance compared with reference-grade instruments will be presented, and preliminary temporal and spatial results from the air quality sensor network will be shown, including the June 2023 Canadian wildfire event.

9IM.21

Performance Evaluation of Low-Cost PM Sensor Based on Light Scattering According to Particle Size: Focusing On Coincidence Effect. KEUN TAEK KIM, Horim Kim, Xin Zhao, Hyeri Jo, Sangjae Jeong, Jae Young Kim, *Seoul National University*

The accurate measurement of particulate matter (PM) concentrations is crucial for assessing air quality and understanding its impact on human health. However, low-cost particulate matter sensors often suffer from limitations due to factors such as temperature, relative humidity, and the coincidence effect. This study aims to investigate the coincidence effect, a phenomenon where small particles pass the detecting zone simultaneously and are erroneously classified as larger particles. We examined this effect, caused by particles under 1 µm, on the measurement of $PM_{2.5}$ and PM_{10} concentrations. The PM concentrations reported by the Plantower PMS7003, low-cost sensor, was compared to those reported by the Grimm 11-D, reference sensor. To assess the coincidence effect, a controlled chamber tests were conducted by utilizing atomized KCl particles under 1 µm. The experimental setup allowed for precise control over the concentration of particles in the chamber. By adjusting the flow rate entering the atomizer, we managed to modify the concentration of fine dust in the chamber. We then observed an increasing concentration of PM_1 and quantified their impact on the $PM_{2.5}$ and PM_{10} concentrations. The results of the chamber tests revealed a clear relationship between PM_1 concentration and the coincidental misclassification of particles as $PM_{2.5}$ and PM_{10}. As the concentration of PM_1 particles increased, a higher number of coincident events occurred, leading to a significant overestimation of $PM_{2.5}$ and PM_{10} concentrations by PMS7003. The R^2 values correlating $PM_{1.0}$ with the overestimated $PM_{1.0\text{-}2.5}$, and $PM_{1.0}$ with the overestimated $PM_{2.5\text{-}10}$, were 0.99 and 0.95, respectively. These findings highlight the importance of understanding and addressing the coincidence effect when using low-cost PM sensors for accurate air quality monitoring. By quantifying the coincidence effect caused by particles under 1 µm, this study emphasizes the need for improved sensor design and calibration methods to minimize measurement errors.

9IM.23

Real-Time Measurement of Aerosol Size Distributions with the Fast Integrated Mobility Spectrometer (FIMS). DAISY WANG, Jiaoshi Zhang, Jeremy Buhler, Jian Wang, *Washington University in St. Louis*

While the Fast Integrated Mobility Spectrometer (FIMS) has greatly improved aerosol size distribution measurements with its ability to capture data within a size range of 10 to 600 nm at a time resolution of 1 second, its offline analysis mode has imposed certain limitations. Abrupt temporal changes in the observed aerosol size distribution are identifiable only hours later, during post-measurement data analysis. This delay between data collection and analysis impedes real-time detection of swiftly changing aerosol environments and of instrument anomalies during data collection.

To overcome these limitations, we developed a real-time data analysis pipeline for FIMS, enabling continuous computation of size distributions during sampling. Our pipeline comprises two computational stages: image processing, which detects particles passing through the FIMS detector and calculates their residence time within it; and data inversion, which employs Twomey inversion to translate observed particle counts within some time window to a particle size distribution. Real-time analysis requires processing images at a rate of 10 Hz and combining particles counted from multiple successive images to produce an updated distribution each second.

Our work gives FIMS the ability to characterize a broad aerosol size range with low delay and high temporal resolution. Efficiency tests on a Raspberry Pi 4 processor show that our pipeline can process an image in 38ms and invert a vector of counts in 69ms, well below the requirements of 100ms and 1000ms, respectively, to produce an updated distribution every second. Imposing a delay of 2.4 seconds between image processing and inversion is sufficient to produce results in 100% agreement with offline methods. Our efficient C++ code allows compatibility with embedded platforms, expanding FIMS' reach. Our work allows real-time aerosol environment monitoring, eliminating lengthy delays between data collection and analysis and boosting FIMS' potential for aerosol research.

9IM.24

Characterization of a Commercially Available Aerosol Raman Hyperspectral Imaging Instrument for Single Particle Analysis. MAXWELL FREEMAN, J. Alex Huffman, *University of Denver*

Aerosol particles play critical roles in climate forcing, as nuclei for ice and cloud formation, and have had increasingly prominent impacts on human respiratory health in recent years. Raman spectroscopy provides structural chemical information that facilitates the detection and identification of particles of various compositions. The Aerosol Raman Hyperspectral Imager (ARHI), commercially available through Battelle as the Resource Effective Bio-Identification System (REBS), was designed primarily to detect airborne agents of biological warfare, but can also be applied more broadly for the measurement of particles of biological and non-biological origin. Here we present preliminary data demonstrating the ability of the ARHI to detect and identify different aerosol materials, and we compare its performance to a commercially available aerosol fluorescence instrument.

9IM.25

Characterization of Aerosolized Micro-/Nanoplastic Aerodynamic Diameter. GINA M. MORENO, Richard Cavalere, Andrea J. Tiwari, Maynard Havlicek, Daniel Bissell, Phoebe A. Stapleton, *Rutgers University*

Plastics and small plastics particles are ubiquitous in all environmental compartments including surface waters, soil, atmosphere, and biota. Micro- and nano-plastics (MNPs) include particles 5mm-1nm in one dimension. Smaller sized MNPs have the potential to aerosolize. Toxicity due to inhalation of MNPs is not well understood. Modeling shows that aerosolized MNPs' deposition sites within the nasal passageway or deeper respiratory tract greatly depends on particle size. Toxicological endpoints from exposure to MNPs may result in inflammation, oxidative stress, or translocation into systemic tissue. Characterization of aerosolized particle size distribution is critical to understanding the physiologic outcomes of MNP inhalation based on particulate size. The purpose of this study was to thoroughly characterize the size range of aerosolized polyamide particles. Using our custom rodent inhalation facility (IEStechno Morgantown, WV), to produce a low (1.01 ± 0.17 mg/m^3) and high (9.98 ± 3.14 mg/m^3) concentration of polyamide particles (Arkema, King of Prussia, PA) we measured the aerosolized particle size distribution in real-time a scanning mobility particle sizer (SMPS™), coupled with an aerodynamic particle sizer® spectrometer (APS™) (both from TSI, Shoreview, MN) quantifying particles 1nm-1000nm and 0.5µm-20µm respectively. Multi-day studies were conducted to assess intra- and inter-day variability. The data were merged, and a multi-peaked plot revealed a bimodal distribution of particles, with the most predominant size fractions at each concentration were 83.64 ± 11.75 nm (SMPS) and 3.11 ± 0.04 µm (APS) at the low concentration and 137.81 ± 29.53 nm (SMPS) and 3.234 ± 0.04 µm (APS) at the high concentration, indicating variation in particle size distribution at low and high concentrations. Particulate size is critical in determining toxicologic outcome from inhaled MNPs. The 83 billion metric tons of plastic already produced inevitably are degrading and rapidly. This will produce higher concentrations of MNPs, which is a human health risk.

9IM.26

Real-Time Separation and Detailed Characterization of Aspherical Submicron Aerosols. SCHUYLER LOCKWOOD, David Bell, Alla Zelenyuk, *Pacific Northwest National Laboratory*

Particle shape plays an important role in determining particle properties and behavior. We have developed several different approaches that make it possible to identify in real-time the presence of particles of different shapes, separate them based on their shape for in-situ and offline analysis, and characterize their chemical and physical properties. These approaches rely on the simultaneous sequential characterization of aerosol particles by two or three instruments that are traditionally used for characterization of submicron aerosol particles.

Here we employ different combinations of instruments (1) Centrifugal Particle Mass Analyzer (CPMA), used to measure particle mass distributions or select particles with narrow distribution of masses; (2) Scanning Mobility Particle Sizer (SMPS) or a differential mobility analyzer (DMA), used to measure particle mobility size distributions or select particles with narrow distribution of mobility diameters; (3) Aerodynamic Aerosol Classifier (AAC), used to measure particle aerodynamic size distributions or select particles with narrow distribution of aerodynamic diameters; and (4) single particle mass spectrometer, miniSPLAT, used to characterize vacuum aerodynamic diameters and composition of individual aerosol particles.

We will present the results of a recent study, in which these approaches were successfully applied for detailed characterization of spherical particles with different composition and densities, and aspherical particles with different compositions, shapes, and morphologies, including fractal and compact agglomerates of nanoparticles.

9IM.27

Development of a Chemical Sense Aerosol Testing Capability.

Will Sellors, GEORGE SPENCE, Sarah Marchant, Peter Jones, *Dstl, Porton Down, Salisbury, Wiltshire, SP4 0JQ, UK*

Dstl supplies specialist services to MOD and wider government, working collaboratively with external partners in industry and academia worldwide to provide expert research and support. Within Dstl, Chemical, Biological and Radiological (CBR) Sciences Division aims to deliver integrated research, development and advice on all aspects of counter-CBR Defence and Security. The Chemical Sensing Team specialises in the development of sensors to detect, identify and monitor chemical threats.

Next generation chemical sensors are required to detect airborne hazards in the aerosol phase. A bespoke facility for safe and controlled generation of aerosols of toxic chemicals has been developed to support the test and evaluation (T&E) of new prototype chemical sensors.

Utilising low hazard materials in a model system, technical innovations have been implemented to progressively improve the stability and reduce the temporal variability of aerosol challenges generated. Commercial automation software has been used to provide control and data acquisition of individual system components through a consolidated Human Machine Interface (HMI) for the system.

The system has been characterised to deliver wide range of control over the concentration of toxic material delivered to systems under test (SUTs). Integrated bespoke and Commercial Of The Shelf (COTS) components have been implemented to provide humidity control, environmental conditioning of SUTs, and rapid switching between aerosol challenges and clean air. This comprehensive T&E capability will allow future chemical sensors to be assessed under situationally relevant conditions.

9IM.28

A Modular Research Tool for Evaluation of Toxic Chemical Aerosol Detectors.

DINESH DURÁN JIMÉNEZ, Tom Venema, Duurt Alkema, Ruud Busker, Arjan van Wuijckhuijse, *TNO*

Concerns over the possibility of deliberate release of low volatile chemical warfare agents and highly toxic pharmaceutical based agents as aerosols has raised the need for a critical technology assessment of the current detection and protection capabilities of armed forces and law enforcement agencies. We here present the realization of a tool to evaluate chemical detectors against chemical aerosols, i.e. the Chemical Hot Aerosol Research Tool (CHART).

CHART has been developed for Test and Evaluation applications of military off-the-shelf and commercial off-the-shelf detectors for highly toxic chemical aerosols in a safe and representative environment. Advantageously, CHART has been developed in a modular fashion, so it can additionally be exploited for physical protection, toxicology and agent fate assessment studies.

Liquids and solids can be dispersed in an aerosol nebulization chamber. A broad dynamic particle size range, including the required particle range of 0.5 to 3 µm for detector evaluation can be offered to the system under test at a dynamic mass range of 0.01 – 20 mg/m3. The aerosol generated is characterized in real time by an optical particle counter, scanning mobility particle sizer and aerodynamic particle sizer detection.

The present study focuses on the current characteristics and future capabilities of the CHART as a validated, safe, toxic chemical aerosols Test and Evaluation tool for detectors. Evidently, in the design of the CHART system emphasis was on laboratory safety and optimal containment of toxic chemicals.

CHART provides a safe and controlled system for generation and containment of toxic aerosols consisting of solid or liquid particles. The set-up and validation of the CHART system will be presented, exemplified by preliminary detector tests.

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9NM.1

High-Resolution Differential Mobility Analysis (HR-DMA) of Nickel Oxide Nanoparticles Synthesized in Flat Premixed Droplet Seeded Flame (FPDSF).

Farnaz Khosravi, Owen Fuhr, Dylan Errico, Mahmoud Ashour, Christian Bjork, FRANCESCO CARBONE, *University of Connecticut*

A Flat Premixed Droplet Seeded Flame (FPDSF) facility is used to synthesize Nickel Oxide (NiO) nanoparticles smaller than 10 nm from a monodisperse aerosol of a nickel (II) nitrate water solution. The FPDSF facility is composed of a Berglund-Liu-type Vibrating Orifice Aerosol Generator (VOAG) which produces monodisperse micron-scale droplets of the nanoparticle precursor solution. The aerosol is mixed with the gaseous combustion reactants within a 3D-printed burner coupling device which conveys the aerosol to the burner nozzle where a honeycomb stabilizes the desired FPDSF. NiO nanoparticles are synthesized as a result of the fast oxidative pyrolysis of the nickel nitrate. This work presents the Size Distribution Functions (SDFs) of the naturally charged fraction of the synthesized NiO nanoparticles as measured by High-Resolution Differential Mobility Analysis (HR-DMA) at several Heights Above the Burner (HAB), from 15 mm to 40 mm. The flame products are sampled continuously through a micron-sized orifice (whose diameter is either 0.25mm or 0.36mm) drilled in the middle of a thin-walled (0.127mm) tubular probe. They are diluted rapidly in 30slpm of pure nitrogen crossing the probe, before being conveyed to the inlet slit of a Half-Mini HR-DMA. A Faraday Cup Electrometer counts the size-classified charged materials that exit the HR-DMA and whose mobility diameter is selected by stepping the HR-DMA control voltage. The results show that the synthesized nanoparticles emerge from the blue flame front with a bimodal SDF at HAB lower than 15mm. Interestingly, the second mode of SDF disappears progressively at increasing HABs, resulting in an approximately lognormal SDF centered near 3.5nm. The SDF center shifts to only slightly larger mobility diameters as nanoparticles age and grow in the flame. Additional measurements are being performed using a diffusion charging approach to quantify the nanoparticles that are neutral within the flame.

9NM.2

NIR-shielding and Visible-light-tranmitted Tungsten Bronze Particles.

Hao Tu, DA-REN CHEN, *Virginia Commonwealth University*

Solar radiation, specifically near-infrared (NIR) radiation, through transparent media (e.g, glass windows) is one of heating sources for transportation vehicles, buildings and houses. HVAC systems are used to control the temperature in the above indoor environments. The effective shielding of NIR from entering the indoor environments could save energy consumption and operational cost of HVAC systems. Tungsten bronze is a NIR shielding material which absorbs the whole NIR and transmits visible light. In the particle form, tungsten bronze particles can be applied on transparent media as a means to control the temperature of indoor environments under the solar radiation. However, liquid-based methods for the production of tungsten bronze particles are energy- and time- consuming. They are also batched. More, tungsten bronze particles are randomly suspended in a transparent carry media for NIR shielding applications. The optical performance of tunstgen-bronze-particle-suspeded media has not been investigated via the modeling.

In this work, we proposed various setups for the continuous production of tungsten bronze particles via aerosol-assisted synthesis. Multiple setups are presented for working with different precursors and solvents. The effects of precursor and solvent were also experimentally investigated. It is shown that tungsten bronze particle in high quality can be produced by cheap and environmentally friendly precursor and solvent. In addition, based on the previous works on the NIR-shielding particles of different metrails, we hypothesized that the size of tungsten bronze particles will have its effect on the optical performance. MOUDI were used to classify as-prodiced particles and the optical performance of classified particles was evaluated. It is shown that the most suitable size of tingsten bronze particles for the NIR shielding can be found via the index of SETS (Solar Energy Transmittance sSelectivity). As a result, the improved optical performance of tungsten bronze particles can be achieved by tuning the particle size. The modeling approach was applied to study the optical performance of tungsten-bronze-particle-suspended madia. Different from the previous works focused on a single particle, this modeling took into consideration of multiple light scattering in the media. The effects of the particle size, concentration and shape on the optical performance of tungsten-bronze-particle-suspended madia were studied. The detail of our work will be presented.

9NM.3

Direct Carbon Capture Repeatability of Magnesium Oxide (MgO) Nanoparticles Synthesized by Aerosol Methods at Room Temperature.

KYUNGIL CHO, Yeryeong Kang, Jihye Park, Sukbyung Chae, Changhyuk Kim, *Pusan National University*

Climate change has caused more frequent extreme weather events than ever. For mitigating climate change, carbon dioxide (CO_2) should be removed and reduced from the flue gas and the atmosphere. Mineral Carbonation is one of promising direct carbon capture technologies using the alkaline earth metal oxides such as magnesium oxides (MgO). Cho et al. reported that aerosol processed MgO NPs showed direct carbonation with less hydration during the wet based carbonation processes, different with the commercial ones. In this study, the effects of the direct carbonation characteristics of the MgO NPs on the durability of direct carbon capture performance were investigated through repeated carbonation and decarbonation processes.

The MgO NPs were synthesized by two aerosol methods and mixed with D.I. water in flasks for continuous direct carbon capture of pure CO_2 (99.99%). While the carbonation, magnetic stirring was applied for uniform carbonation with constant RPM. pH of the MgO slurries were monitored during the carbonation processes to check the end of the processes. Carbonates were dried in the oven and decarbonated at 800℃ in a furnace. The carbonation and decarbonation processes were repeated up to 15 cycles. The changes of morphology and chemical composition of the MgO NPs and carbonates were analyzed with the carbon capture amounts per unit mass of the adsorbents.

The MgO NP based CO_2 adsorbents showed less hydration and direct carbonation during the repeated carbonation experiments. After the carbonation, the MgO NPs were transformed into pillar shaped carbonates. Interestingly, the carbonates did not return to their original shapes of MgO NPs, even though the chemical compositions were MgO. The decarbonated particles had porous surface pillar shapes, where CO_2 gas molecules were adsorbed during the carbonation processes. The change of CO_2 adsorption capacity for each MgO NP will also be discussed as a function of repeating cycles.

9NM.4

The Effect of Cooling Rate on Crystallinity of Au Aerosol Nanoparticles.

YI WANG, Sotiris Pratsinis, *ETH Zurich, Switzerland*

Gold nanoparticles find widespread applications in many technological areas, such as medicine, microelectronics, and sensing. Their chemo-physical properties strongly depend on their crystalline structures, making investigations into crystallinity crucial. Molecular dynamics simulations employing the embedded atom method are conducted [1] to investigate the formation of Au crystals by gas-phase (flame, plasma, laser, etc.) processes. Non-isothermal homogeneous crystallization simulations are performed at various cooling rates for Au nanoparticles of different sizes, and their crystallization evolution is examined. The crystalline extent of nanoparticles, predominantly face-centered cubic with some hexagonal close-packed structures near their surface, is quantified based on their local crystalline disorder. The appearance, growth and coalescence pathways of the crystals are tracked through cross-sectional trajectories. The steep decline of the average atomic potential energy and amorphous fraction marked the crystalline transition at the end of the metastable phase region, which occurs earlier for larger particles. Subsequently, the crystals continue growing as temperature decreases, resulting in less distorted atoms at the grain boundaries and outer surface with more recognizable crystal domains. The retained atoms fraction is used to quantify the transition from sub-critical to supercritical nuclei and thus the onset of nucleation. X-ray diffraction patterns are generated [2] from which the dynamics of crystal growth are elucidated and compared to direct tracing and mapping of crystal sizes, revealing that lower cooling rates and larger particle sizes produce larger crystals. The impact of cooling rates on larger particles is more significant in terms of the final crystallite sizes. The crystallization is prolonged and the final crystallite size is larger at lower cooling rates than at higher ones as the modified Avrami equation is employed for describing the crystallization kinetics.

[1] Goudeli, E. and Pratsinis, S. E. (2016) AIChE J. 62:589-98.
[2] Goudeli, E. and Pratsinis, S. E. (2017) ACS Nano. 11:11653-60.

9NM.5

A Pelletizing Method for the Mass Synthesis of Functionalized-Polyethylenimine-Based Adsorbents for Carbon Dioxide Capture in Continuous Exhaust Gas Flow Conditions. YOUNGHUN KIM, Inyong Park, Dae Hoon Park, Gunhee Lee, Jungho Hwang, Bangwoo Han, *Korea Institute of Machinery & Materials, Yonsei University*

Polyethylenimine-based adsorbents have been actively investigated for carbon dioxide capture emitted post-combustion. Most of the previous studies on polyethylenimine-based adsorbents have focused on the powder or particle form. Powder or particle adsorbents applied to exhaust gas aftertreatment of facilities or mobilities can cause adsorbent loss due to exhaust gas flow. In this study, we report the pelletization by extrusion of a functionalized-polyethylenimine (PEI)/silica adsorbents for application in exhaust gas aftertreatment. The pellet-type substrates were extruded using a silica-based material, and an organic binder was added to maintain a pellet shape. After extrusion, the organic binder was calcined at about 150-750 ℃. The pellet-type substrates calcined at about 550 ℃ had the highest total pore volume (0.98 cm^3/g). The calcined pellet-type substrates were impregnated with functionalized-PEI. To demonstrate the carbon dioxide adsorption efficiency of the functionalized PEI/silica adsorbents according to the calcination temperature, we measured the carbon dioxide concentration at the downstream of the adsorbents for about 5 min in approximately 5% carbon dioxide continuous gas flow conditions (50 L/min). The average carbon dioxide adsorption efficiency for 5 min of the adsorbents was also the highest at 550 °C calcination conditions (22.64%). In addition, the functionalized PEI/silica adsorbents calcined at 550 °C were saturated upon carbon dioxide adsorption for about 90 min (1.05 mmol/g).

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9NM.6

Experimental Study on the Fabrication of Light-transmitting Air Filter using Electrospinning. INYONG PARK, Younghun Kim, Sang Bok Kim, Gunhee Lee, Dae Hoon Park, Kee-Jung Hong, Dongho Shin, Bangwoo Han, *Korea Institute of Machinery & Materials*

Electrospinning is simple versatile technique to produce polymeric nanofibers by means of electrostatic force. Electrospun fibers typically have a diameter of several tens of nanometers to several micrometers. Recently, there has been a promising interest in utilizing polymeric nanofibers as dust collection devices capable of filtering fine dust particles from the atmospheric aerosol. Notably, the fine fibrous structure can help to achieve a high filtration efficiency with low pressure drop.

In this study, we aimed to develop a light-transmitting filtration device that can be directly applied to windows by employing electrospinning on a metal mesh substrate. We evaluated the performance of the electrospun nanofibrous filters in terms of filtration efficiency and light transmittance. The experimental results show that the electrospun nanofiber filters have a high filtration efficiency of over 90% while maintaining light transmittance of 70%. Furthermore, we have demonstrated the feasibility of adding functional materials into the polymer solution directly, allowing for the application of diverse functionalities to the filter material.

9RA.1

Seasonal Differences of New Particle Formation Characteristics Based on the Real-Time Measurements of Aerosols in South Korea.

YOONKYEONG HA, Jeongbeen Kim, Soodong Lee, Kyungil Cho, Ji Yi Lee, Kyoung-Soon Jang, Mijung Song, Joonyoung Ahn, Kwangyul Lee, Changhyuk Kim, *Pusan National University*

New particle formation (NPF) including gas-to-particle conversion and the growth of particle nuclei is a key to understand secondary aerosol formation processes in the atmosphere. This is well known to contribute significantly to the haze episodes in the Northeast Asia including South Korea.

In this study, four monitoring campaigns for atmospheric aerosol characteristics were conducted during 2020/12/15 - 2021/01/15 (winter), 2021/06/01 - 2021/06/30 (summer), 2022/03/14 – 2022/04/13 (spring) and 2022/11/10 – 2022/12/10 (autumn) at suburban and metropolitan sites in South Korea (Seosan and Seoul, SS and SE). During these campaigns, number size distributions and mass concentrations of $PM_{2.5}$ (PNSD and $C_{PM2.5}$) were measured in real-time as well as particle chemical compositions, concentrations of gas pollutants and meteorology data. Seasonal NPF characteristics such as condensation sink (CS), coagulation sink (CoagS), growth rate (GR), formation rate (FR) and nucleation rate (NR) were calculated based on PNSD data. These were compared with other real-time measurement data. Yellow dust events influenced on the air quality of the partial periods in the winter and spring campaigns.

During the campaigns, CS followed the trend of CoagS with one higher order of magnitude. NPF events generally occurred when $C_{PM2.5}$ was below 35 $\mu g/m^3$. In addition, frequency of NPF events was higher in winter than in summer. FRs observed at SE were higher in winter than in summer, but GRs at the site were higher in summer. Even though GRs monitored at SS were higher in summer as that at SE, FRs at SS were also higher in summer. FRs and GRs in spring and autumn campaigns were in the middle of the values shown in winter and summer. NRs for each season and site will be also discussed to compare the NPF characteristics with those reported in the literature for Chinese megacities.

9RA.2

Formation of 2-Methyltetrol and 2-Methylglyceric Acid in the Northern Hemisphere from Marine Isoprene Emission.

JIE ZHANG, Minsu Choi, Junyi Liu, Xiang Ding, Mei Zheng, Qi Ying, *Texas A&M University*

Field measurements have shown that isoprene emitted from ocean surfaces are significant. However, their contributes to secondary organic aerosol (SOA) formation in the polluted and remote marine troposphere have not been accurately quantified. In this study, we used a modified hemi-spheric community multiscale air quality model (hemisphere CMAQ) to study the formation of 2-methyltetrols (2-MT) and 2-methylglyceric acid (2-MG) due to isoprene emissions originated from chlorophyll-a and marine and sea surface microlayer in the northern hemisphere. The modified hemi-sphere CMAQ model considers the formation of 2-MT and 2-MG from the acid-driven reactive surface uptake of isoprene epoxide (IEPOX), methacrylic acid epoxide (MAE), and hydroxymethyl-methyl-α-lactone (HMML). In addition, it considers the photochemical decay of 2-MT and 2-MG in gas and aerosol aqueous phase, and the gas-aqueous-organic phase partitioning. The emissions of isoprene and other biogenic VOCs from on-land sources are also considered in the model using the estimations from the Model of Emissions of Gases and Aerosols from Nature (MEGAN), and anthropogenic emissions are based on the EDGAR emission inventory. Our simulations will reveal the concentrations of the marine-originated isoprene tracers and total SOA in various parts of the marine boundary layer in the northern hemisphere and their contributions to total SOA loading.

9RA.3

A Study on Elevated Fine Particles at a Crop-Agricultural Site in Gimje, South Korea: Impact of Local Sources on Event Days. JOONWOO KIM, Jiho Jang, Dahye Oh, Haebum Lee, Kihong Park, *Gwangju Institute of Science and Technology*

Crop-agricultural areas are sources of emissions such as carbonaceous species from crop residue burning and nitrogen species from fertilizer use. We measured gases and fine particles at a crop-agricultural site in Gimje, South Korea during the summer of 2021, to examine the influence of local sources on the formation of fine particle events under accumulation conditions. Two types of fine particle events were identified: crop residue burning and nitrate formation. During the fine particle event period with intensive open burning of crop residue, we observed drastically elevated levels of organic carbon (OC), elemental carbon (EC), black carbon (BC), potassium, chloride, and elements in fine particles. $BC_{\text{biomass burning}}$ was higher than $BC_{\text{fossil fuel combustion}}$ and EC. Water-soluble OC was higher than water-insoluble OC, with the strong enhancement of formaldehyde (HCHO), glyoxal (CHOCHO), nitrogen dioxide (NO_2), nitrous acid (HONO) and ozone (O_3), implying secondary organic aerosol formation. On other fine particle event days, nitrate dominated in fine particles with high aerosol water content (AWC). The particle fraction of total (gas + particle) nitrate was significantly increased depending on AWC, in addition to high levels of aerosol pH influenced by abundant ammonia (NH_3). Furthermore, total nitrate levels were not decreased although NO_2 levels were low. The variations of total nitrate were associated with HCHO variations, not local NO_2 variations, in the transition regime of O_3 formation. Our results show that crop residue burning and NH_3 emissions contributed to fine particle pollution at a crop-agricultual site.

9RA.4

Low-cost Sensor Network for Monitoring Indoor, Outdoor, and Personal PM2.5 Exposure in Seattle during the 2020 Wildfire Season. Jiayang He, Ching-Hsuan Huang, Elena Austin, Edmund Seto, IGOR NOVOSSELOV, *University of Washington*

The increased frequency of wildfires in the Western United States has raised public awareness of the impact of wildfire smoke on air quality and human health. Exposure to wildfire smoke has been linked to an increased risk of cancer and cardiorespiratory morbidity. Evidence-driven interventions can alleviate the adverse health impact of wildfire smoke. Public health guidance during wildfires is based on regional air quality data with limited spatiotemporal resolution. Recently, low-cost air quality sensors have been used in air quality studies, given their ability to capture high-resolution spatiotemporal data. We demonstrate the use of a network of low-cost particulate matter (PM) sensors to gather indoor, outdoor, and personal PM2.5 exposure data from seven locations in the urban Seattle area, along with a personal exposure monitor worn by a resident living in one of these locations during the 2020 Washington wildfire event [1]. The data were used to determine PM concentration indoor/outdoor (I/O) ratios, PM reduction, and personal exposure levels. The result shows that locations equipped with high-efficiency particulate air (HEPA) filters and HVAC filtration systems had significantly lower I/O ratios (median I/O = 0.43) than those without air filtration (median I/O = 0.82). The median PM2.5 reduction for the locations with HEPA is 58 % compared to 20% for the locations without HEPA. The outdoor PM sensors showed a high correlation to the nearby regional air quality monitoring stations (R2 = 0.93). The personal monitor showed high variance in PM measurements as the user moved through different microenvironments and could not be fully characterized by the network of indoor or outdoor monitors. The findings imply evidence-based interventions can be developed for reducing pollution exposure based on the combination of indoor, outdoor sensors. Personal exposure monitoring in individuals' breathing zones provided the highest fidelity data capturing temporal spikes in PM exposure.

[1] He, J., et al., Network of low-cost air quality sensors for monitoring indoor, outdoor, and personal PM2.5 exposure in Seattle during the 2020 wildfire season. Atmospheric Environment, 2022. 285: p. 119244.

9RA.5

Multi-modal Chemical Characterization of Brown Carbon in Atmosphere and Snowpack from the Colorado Rockies.

STEVEN SHARPE, Kyla Siemens, Felipe Rivera-Adorno, Jay Tomlin, Nurun Nahar Lata, Zezhen Cheng, Erik Hulm, Matthew Fraund, Ryan Moffet, Swarup China, Alexander Laskin, *Purdue University*

Snowpack in the Colorado Rockies is a crucial source of fresh water, which also provides terrestrial transport of nutrients and carbon for the arid Southwest United States. The lifetime and evolution of alpine snowpack is influenced by the deposition of light absorbing particles (LAPs), principally black carbon (BC), brown carbon (BrC), and mineral dust (MD). Deposition of LAPs decreases snow albedo and accelerates snowmelt. We have employed multi-modal chemical imaging (CI) and molecular characterization (MC) techniques for comprehensive analysis of airborne particles and snow pollutants collected at Gothic, CO as part of the Surface-Atmosphere Integrated Field Laboratory (SAIL) campaign. In this study, we characterize aerosol regimes, quantify optical and chemical properties of LAPs within snowpack, and use optical and chemical properties of LAPs to inform modeling estimates of the radiative forcing attributed to atmospheric and surface-deposited LAPs. Specific tasks of our study included: 1) deployment of an aethalometer and a time-resolved aerosol collector to provide real-time monitoring and sampling of light-absorbing aerosols. 2) Aethalometer filters were analyzed with Direct Analysis in Real Time (DART) high resolution mass spectrometry aided with temperature programed desorption to assess gas-condensed phase partitioning of aerosol components. 3) Analysis of snow-deposited LAPs using CI and MC techniques. 4) multi-modal high-resolution microscopy analysis of airborne LAPs sampled by a tethered balloon system deployed at Gothic to investigate differences in individual aerosol composition and morphology at various altitudes. Comprehensive data sets from this study will inform particle-resolved models that account for individual particle complexity and modeling of snow spectral albedo under different contamination scenarios in Colorado.

9RA.6

Exploratory Overview of University Mountain Campus in the Front Range of Colorado for Possible Future Atmospheric Research.

J. ALEX HUFFMAN, Maxwell Freeman, Paola Gascot, Alyssa Knaus, Aleksandra Volkova, Olivia Wuttke, *University of Denver*

The University of Denver recently purchased the James C. Kennedy Mountain Campus (KMC), a former Girl Scouts camp in the Roosevelt National Forest, near the Red Feather Lakes in northern Colorado. The KMC is a 720 acre campus in the northern Front Range region, with year-round road access as well as ample power, water, internet, and logistical infrastructure such as dining and accommodation facilities. The campus is 36 miles from Fort Collins, 83 miles from Boulder, 61 miles from Laramie, WY, and 105 miles from downtown Denver. Because of the proximity of the KMC to a number of Front Range universities and national research institutions, the new facility may offer opportunities to develop a research station in the rural mountains for collaborative use. Several particulate matter (PM) sensors (Purple Air and MODULAIR-PM from QuantAQ) were deployed in late summer 2023 as a first effort to begin understanding the PM properties of the campus. The poster will provide a basic overview of the new campus, including infrastructural resources, historical meteorological trends, and newly acquired PM data. The purpose of the poster is to help begin a conversation towards whether a more permanent atmospheric research station could provide collaborative benefit to the community.

9SA.1

Feature Extraction and Prediction of PM2.5 Chemical Constituents in Seoul Using GAIN Machine Learning Models.

SONGKANG KIM, Jieun Park, Ilhan Ryoo, Taeyeon Kim, Yeonseung Cheong, Hyejin Shin, Sunghwan Shim, Sujung Han, Minsu Kang, Seung-Muk Yi, *Seoul National University, Seoul, Korea*

Fine particulate matter (PM2.5) is a significant component of air pollution and has been linked to adverse health effects, making its continuous monitoring crucial. Despite the high cost and time required to obtain PM2.5 chemical composition, complete and reliable data are not always available. Missing values in PM2.5 chemical composition data are a common challenge in data interpretation and limit the usefulness of available data. Additionally, imputing missing values of PM2.5 chemical composition is challenging due to its complex nature. Also, incomplete data can reduce the accuracy and reliability of modeling results, such as source apportionment. Previous studies have used real-time data to interpolate missing values between observed data, but we used data collected through a sampler that collects atmospheric aerosols for 24 hours once every 3 or 6 days using 3 channels. PM2.5 constituent consists of 3 groups, namely 6 ions, 2 carbons, and 20 trace elements, were targeted for prediction. Our study evaluated the applicability of feature extraction using machine learning models to predict missing values among the observed chemical constituents of PM2.5, in order to improve the reliability and availability of the data. We employed several machine learning models, and among them, the generative adversarial imputation network (GAIN) had the highest predictive power. The prediction accuracies of each model were compared to evaluate their applicability with stepwise increases in the input data and changes in the components to be predicted. Also, source apportionment was performed using the PMF model for the data generated using the predicted results and the data without interpolation of missing values. Our study aimed to compare and test the performance of the missing value interpolation method through the model for not only real-time data with many measured values but also directly sampled data with a small number of data based on each result.

9SA.2

Elemental Characterization and Source Apportionment of Fine Particulate Matter (PM2.5) in Industrial and Non-Industrial Areas of Lagos State, Nigeria.

IFECHUKWUDE CHIEDU, Faith Oyibo, *Federal Institute of Industrial Research Lagos, Nigeria.*

Air pollution is initiated by substances in the air caused by natural emissions or by anthropogenic (originated by humans) activities. Some particulates come from natural sources such as evaporated sea spray, windborne pollen and entrained soil dust. Particulates from natural sources tend to be coarse. Almost all fine particulates are generated as a result of combustion processes, including the combustion of fossil fuels for steam generation, heating and household cooking, agricultural field burning, diesel-fuelled engine combustion, and various industrial processes. Particulate matter (PM) which can be inhaled into the human respiratory system is related to most serious health effect including pulmonary and cardiovascular illness.

The fine particulate matter ($PM_{2.5}$) was collected using Casella Cel-712 Microdust Pro Real-time Dust Monitor with polyurethane foam (PUF) and a glass fibre filter (GFF).The sampler was placed at heights of 1.5m above ground level and within the human breathing zone. The glass fibre filter (GFF) was used to collect the fine particulate matter. The sampler was connected to a pump with a flow rate of 2L/min for a sampling period of 8 hours/day. Based on the field study conducted, the concentrations of $PM_{2.5}$ at the different locations vary with respect to anthropogenic sources. The $PM_{2.5}$ levels obtained ranged from 14.00 to 32.67µg/m3during wet season and 18.67 to 34.67µg/m3during dry season. Trace elements were determined using Atomic Absorption Spectrophotometer.

The elements: Pb, Cd, Cr, Cu and Ni, in the fine fraction ($PM_{2.5}$) is a signature of anthropogenic sources. Principal Component Analysis (PCA) studies explained two common contributing sources of fine particulates ($PM_{2.5}$) such as entrained soil and combustion. Correlation matrix which reflects the association between elements and the similarity of their pollution sources was also determined and some of the elements were strongly correlated while some were not.

9SA.3

Effects of Seasonal Management Programs on PM2.5 in Seoul, Korea Using Dispersion Normalized PMF. ILHAN RYOO, Jieun Park, Songkang Kim, Hyejin Shin, Sunghwan Shim, Sujung Han, Taeyeon Kim, Yeonseung Cheong, Kwon Ho Jeon, Hyeog Ki Chae, Kyungmi Lee, Ju Gyo Lee, Seung-Muk Yi, *Seoul National University*

Particulate matter with aerodynamic diameter equal to or less than 2.5 µm (PM2.5) is classified as class 1 carcinogen by the WHO (World Health Organization) in 2013.

South Korea is a one of the East Asian countries with severe air pollution such as PM2.5, and the government of South Korea has been implementing several policies to reduce PM2.5. The relevant actions were initiated with the forecasting/warning of fine dust in 2014 and the Comprehensive Action Plan on Fine Dust was implemented in 2017. Additionally, the Seasonal Particulate Matter Management System was introduced in December 2019. Since then, this seasonal management system has been enforced from December through March.

Therefore, the present study aims to identify and apportion the PM2.5 sources in Seoul, Korea using Dispersion Normalized Positive Matrix Factorization (DN-PMF) based on South Korea and China joint research program, and to extensively evaluate the effects of seasonal management policy for South Korea by comparing PM2.5 source contributions of the different periods.

Samples using a three-channel low-volume air sampler in Seoul were collected three times from January to December 2019 (before implementation policy period), and from September 2020 to May 2021 (after implementation policy, 1st study period), and from July 2021 to March 2022 (after implementation policy, 2nd study period).

The samples were analyzed for trace elements (fifteen species, Al, Si, Ca, etc.), carbonaceous species (Organic Carbon, Elemental Carbon), and ionic species (six species, SO42-, NO3-, NH4+, etc.). PM2.5 mass concentration and its chemical constituents were applied to DN-PMF for source apportionment. Subsequently, directional analysis of PM2.5 sources was performed using CBPF (Conditional Bivariate Probability Function).

Our results can be used as basic data to establish more effective air pollution control and management policies to reduce PM2.5 in ambient air.

9SA.4

Organic Aerosol Concentration, Composition, and Sources Analysis at Pretoria, South Africa Employing Fourier-transform Infrared Spectroscopy (FT-IR) and Positive Matrix Factorization (PMF). MUHAMMAD NAVEED ANWAR, Satoshi Takahama, Christopher Oxford, Randall Martin, Adele L. Igel, Ann Dillner, *University of California, Davis*

World Health Organization (WHO) estimates that about 91% global population live in polluted air – resulting in approximately 7 million premature deaths annually mostly attributed to Low and Middle Income Countries (LMICs). 98% LMICs' cities, having population >100,000, are non-compliant to WHO air quality guidelines contrary to 56% cities in high income countries. Organic Matter (OM) often dominates PM2.5 mass, sometimes even up to 9/10th of total mass, warranting the need of its quantification particularly in LMICs having limited PM measurements. Unfortunately, the molecular complexity of OM makes quantification challenging and often requires expensive and time-consuming methods. In this study, we demonstrate the capability of Fourier-transform Infrared Spectroscopy (FT-IR) method for providing OM quantification and characterization as a sum of organic functional groups: alcohol, alkane, carbonyl, and carboxyl groups, in the Pretoria, South Africa at a Surface Particulate Matter Network (SPARTAN) site. South Africa falls in the category of LMICs and Pretoria has a 3.3 million population. Polytetrafluoroethylene (PTFE) filters (MTL Corp., PT25DMCAN-PF03A) used for gravimetric, black carbon, FT-IR, ionic and elemental analysis were collected with an AirPhoton SS5 Sampler over 24 hour intervals from April 2021 to April 2022 (71 samples). The mean concentration of PM2.5 was 16 ug/m3 with winter being the most polluted season with remaining seasons appearing in following order: autumn > spring > summer. We present the daily, seasonal, and overall variation of organic composition and OM/ PM2.5 ratios. Source classes and their geographical origins are determined through Positive Matrix Factorization (PMF) of inorganic and organic speciated data and back trajectory analysis. In the future, using the knowledge about these sources and their locations, the appropriate policy measures will be proposed to curb PM2.5 pollution at Pretoria considering the ground based limiting factors and existing mitigation policies.

9SA.5

Source Apportionment Using DN-PMF and Oxidative Potential of PM1.0. HYEJIN SHIN, Taeyeon Kim, Jiwon Ryu, Kwon Ho Jeon, Seung-Muk Yi, *Seoul National University, Seoul, Korea*

Epidemiological and toxicological research have suggested that particulate matter(PM) cause adverse health effects, especially PM1.0 can penetrate deep into the alveolar region of the lungs, and then circulate in the bloodstream. PM1.0 is composed of various chemical constituents, of which organic carbon accounts for a large proportion and is usually found in urban areas.

In this study, we identified the sources of PM1.0 in Seoul and compared not only the characteristics of sources but also oxidative potential with each other. 91 samples were collected over a period of 7 months from September 2021 to March 2022. Three-channel low-volume air sampler and high-volume air sampler were used. The samples were analyzed for carbonaceous species, ionic species, trace elements, and organic compounds.

PM1.0 mass concentration and chemical constituents were applied to Dispersion Normalized Positive Matrix Factorization(DN-PMF) for source apportionment. DN-PMF calibrate the weather effect using the ventilation coefficient calculated by multiplying mixing layer height by the wind speed. For better source apportionment of PM1.0 than previous studies, we included organic compounds, which help the speciation of the organic carbon to specify sources.

The health effects were verified by measuring the oxidative potential using the dithiothreitol(DTT) assay. In addition, multiple linear regression was applied to identify which source more contributes oxidative potential.

These results could identify the sources of PM1.0 and the relevance between source contribution and oxidative potential.

9SA.6

Characterizing Los Angeles Aerosol through Long-Term High-Resolution Measurements. HAROULA D. BALIAKA, Ryan X. Ward, John Seinfeld, *California Institute of Technology*

The Los Angeles basin is one of the most polluted airsheds in the United States. The region's dense urban landscape and its basin topography have allowed for numerous anthropogenic and biogenic pollution sources to accumulate contributing to decades of poor air quality. Over the past decade, various measurements suggest that despite regulations particulate matter levels in Los Angeles have stagnated, renewing interest in the sources and composition of the aerosol. In this work, we conduct field measurements at an urban site located in Pico Rivera, in Los Angeles County, CA. This site is part of the Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT) and is equipped with a suite of advanced aerosol instrumentation for real-time measurements of fine aerosol chemical composition and properties including an Aerosol Chemical Speciation Monitor (ACSM) for the composition and mass concentration of the non-refractory aerosols, an Xact for monitoring trace metals, an Aethalometer for measuring black and brown carbon, and a Scanning Mobility Particle Sizer (SMPS) for the aerosol number size distribution. We perform Positive Matrix Factorization (PMF) on ACSM data and resolve factors consistent with previous studies in Pasadena, CA, such as hydrocarbon-like OA (HOA), cooking OA (COA), more-oxidized oxygenated OA (MO-OOA), and less-oxidized oxygenated OA (LO-OOA).

9SA.7

Source Apportionment of Near-Road Atmospheric Aerosols in Ontario, California. BRADLEY RIES, Yifan Ding, Mohammad Sowlat, Payam Pakbin, Akula Venkatram, Roya Bahreini, *University of California, Riverside*

Direct tailpipe emissions from vehicles in urban environments have reached an all-time low. Because of this, emissions from sources other than the exhaust-such as brake wear, tire wear, and particles resuspended from the roadway itself, are gaining more importance. To study the contribution of these sources to atmospheric aerosols in the Inland Empire of Southern California, we deployed an Xact® 625i Ambient Continuous Multi-Metals Monitor (with an alternating $PM_{2.5}$ and PM_{10} inlet) and Portable Environmental Beta-Attenuation Mass Monitors (E-BAM), one with a PM2.5 and one with a PM10 inlet, at a near-road air monitoring station in Ontario, managed by the South Coast Air Quality Management District. Meteorological parameters and concentrations of NOx, CO, and black carbon, and total particle number (PN) were also measured using Teledyne T200, Horiba APMA 370, Magee AE33 and Teledyne API 651. We will use positive matrix factorization (EPA v 5.0) to determine the contributions of the tail-pipe and non-tailpipe emissions to overall $PM_{2.5}$ and PM_{10} concentrations. Local meteorology as well as diurnal profiles of the measured species and those of the resolved factors will be discussed.

9SA.8

Particulate Emission Characterization of Exhaust from Residential Oil and Gas Fired Heating Appliances. JAKE LINDBERG, Rebecca Trojanowski, Stephen Galvin, Thomas Butcher, *Brookhaven National Labs*

The largest sector of energy consumption in New York State (NYS) is space heating, with the majority of such heating appliances currently using fossil fuels. The northeastern and mid-western United States in general also heat predominantly with fossil fuels such as, oil and natural gas. In 2019 NYS established the NYS Climate Leadership and Community Protection Act which mandates the state transition to 100% renewable energy over the next 30 years, which will result in significant changes to the fuels and technologies used for home heating. Further, the existing emission factor data was developed prior to low-sulfur fuel standards and renewable fuel blending mandates. In this work we seek to describe the emissions and performance of current and emerging heating equipment with current fossil fuels (natural gas and No. 2 oil) such that the emissions and heating performance could be compared to market-ready biofuels such as biodiesel and biogas, as well as emerging renewable fuels such as hydrogen. Specifically described are the particulate emission and heating performance of three residential hydronic heating appliances, two fired with natural gas, and one fired with oil. The appliance selection includes: a natural gas fired forced-air combustion burner, a natural-gas fired diffusion-flame burner, and a single firing rate pressure atomized oil burner. All three appliances are of residential scale and the fuels used are typical of those in NYS. The appliance performance was evaluated using a load-profile test method designed to include transient conditions, such as cyclic-firing, typical of residential use. The specific characteristics of the particulate matter being evaluated include: Particle Mass Concentration (PMC), Particle Number Concentration (PNC), Particle Size Distribution (PSD), and particle speciation (i.e. Black Carbon (BC) and Brown Carbon (BrC) concentrations). Each of which was measured in real-time using a dilution sampling system throughout each experiment.

9SA.9

Investigating Aqueous Processing of Submicrometer Aerosols during the Spring HI-SCALE Campaign in the Southern Great Plains.

JUSTIN TROUSDELL, John Shilling, Jerome Fast, Qi Zhang, *University of California, Davis*

Aqueous phase chemistry of organic compounds in the atmosphere has been recognized as an important source of secondary organic aerosol (SOA), which has implications for both human health and climate. As a part of the ongoing effort to understand aqueous SOA (aqSOA), we performed a comprehensive analysis of data collected by a high-resolution aerosol mass spectrometer (HR-AMS) during the DOE-sponsored Holistic Interactions of Shallow Clouds, Aerosols, and Land Ecosystems (HI-SCALE) campaign at the Southern Great Plains (SGP) site in northern Oklahoma in the spring of 2016. We applied positive matrix factorization (PMF) on a combined matrix of organic and select inorganic ions to isolate distinct SOA factors. A seven-factor solution was found to be the most appropriate environmentally. This solution included three aged biomass burning organic aerosol (BBOA) factors, a biogenic-SOA (BSOA) factor, an aged primary emission OA, an ammonium nitrate (AN) factor and an ammonium sulfate (AS) factor. Both the AN and the AS factor were mixed with oxygenated organic aerosol (OOA) species, although the AS-OOA is more oxidized than the AN-OOA. Available meteorological data, particle sizing data, and NR-PM1 composition were used to select four case study periods to investigate aqueous processing. These case studies provide us with a basis to investigate aqSOA and aqSOA tracer ions for use in the analysis of AMS data.

9SA.10

Source Apportionment of PM2.5 with Continuous Speciation Monitoring Data and Time-integrated Measurements of Organic Markers.

Yi-Hsien Liu, Chun-Sheng Huang, Wei-Cheng Tsai, Ho-Tang Liao, Chia-Yang Chen, CHANG-FU WU, *National Taiwan University*

Exposure to air pollutants such as fine particulate matter ($PM_{2.5}$) causes both acute and chronic adverse health effects. However, $PM_{2.5}$ can be contributed by various air pollution sources. In order to develop effective air quality management plans, identifying major sources of air pollutants is essential. This can be achieved by using receptor models, such as Positive Matrix Factorization (PMF), for source apportionment. In this study, hourly $PM_{2.5}$ measurements of inorganic ions, elements, organic carbon, and elemental carbon were obtained in an urban area in Taiwan for 14 days in winter. Additional 12-h integrated filter samples were collected simultaneously and analyzed for eight organic compounds such as 2-methylerythritol and arabitol by ultra performance liquid chromatography-tandem mass spectrometer (UPLC-MS/MS). The speciation data were analyzed with (Model 2) and without (Model 1) organic species, respectively, by multiple-time-resolution PMF. Through constraining Model 2 using the traffic-related profile generated from Model 1, the biogenic source (estimated contribution=15%) was identified additionally. The other factors were identified as the ones in Model 1: Traffic-related, Road dust, Sea salt, Oil combustion, and Coal burning/Industry. Backward trajectory modeling indicates that the biogenic source was from the mountains areas. The study results suggest that applying organic species could fill the gap in predicted and observed $PM_{2.5}$ concentrations, which is mostly biogenic source in the study area.

9SA.11

Machine Learning Techniques for Rapid Analysis of Particle Morphology and Elemental Composition. BORIS GALVIS, Fabiana Franceschi, Natali Zambrano, David Restrepo, Olga Lucia Quintero Montoya, Jose Duque, Elena Montilla Rosero, Daniela Bustos, Nestor Rojas, *Universidad del Valle*

Morphological characterization and elemental analysis of single particles using scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDX) have been effective techniques for identifying the sources of ambient particles. However, analyzing a large number of particles using these methods can be time-consuming. To address this issue, we developed an image classifier based on machine learning algorithms that utilizes computer vision and pattern recognition to automate a significant portion of the SEM-EDX particle analysis process.

We first tested five different models using SEM-EDX images from NASA's cosmic dust catalog VOL XV and evaluated their performance on the same image set. The models based on EfficientNet and ResNet exhibited the highest accuracy. We then further trained and tested our algorithms using thousands of SEM-EDX images of particles collected in three cities in Colombia (Bogotá, Cali, and Medellín). The algorithm was able to classify particles into four morpho-chemical groups (organic biogenic, metallic, mineral, and tire wear) within hours.

Our image classifier based on EfficientNet and ResNet achieved accuracies of 80% and 85%, respectively. Our ultimate goal is to develop a source apportionment tool based on this technology and compare it to traditional methods.

9SA.13

Molecular Characterization of First- and Second-Generation Oxidation Products of Decamethylcyclopentasiloxane in Ambient Fine Particulate Matter. JEEWANI MEEPAGE, Josie Welker, Saeideh Mohammadi, Christopher Brunet, Hanalei Lewine, Rachel Marek, Keri Hornbuckle, Eleanor Browne, Charles Stanier, Elizabeth Stone, *University of Iowa*

Decamethylcyclopentasiloxane (D_5) is a prominent ingredient in personal care products. It can react to form oxidized volatile methyl siloxanes and contribute to secondary organic aerosol (SOA) in the atmosphere and impact air quality. Yet, the quantitative impact of D_5-derived SOA on ambient fine particulate matter ($PM_{2.5}$) has not been characterized. The focus of this study is to develop molecular markers to track the occurrence of D_5-derived SOA to aid in source apportionment. SOA samples of D_5 oxidation in a laboratory oxidative flow reactor (OFR) are compared to $PM_{2.5}$ collected at a New York City (NYC) field site. Sample extracts are analyzed by reverse-phase liquid chromatography in conjunction with negative electrospray ionization and high-resolution mass spectrometry. A preliminary list of molecular candidates for tracing D_5-derived SOA in the atmosphere has been developed, based on their repeated observation in OFR-generated SOA samples and detection in the NYC field sample by using exact mass, isotopic ratios, product ion spectra, and signal abundance. It includes a homologous series in which a methyl group in D5 (C10H30O5Si5) is replaced by a hydroxyl group: $C_9H_{28}O_6Si_5$, $C_8H_{26}O_7Si_5$, $C_7H_{24}O_8Si_5$, and $C_6H_{22}O_9Si_5$. Among these, the first two homologs were observed in the NYC field sample, while all four were observed in the OFR sample, indicating the presence of multi-step oxidation products in ambient $PM_{2.5}$. Molecular structures for the most abundant homologs are presented, based on their product ion spectra and chromatographic retention time. Because of their specificity to D_5 and demonstrated detectability in ambient $PM_{2.5}$, the identified products may be useful molecular tracers for first- and second-generation oxidation products of D_5-derived SOA.

9SA.14

PM2.5 Source Changes for 2010-2019 in New York and New Jersey by Dispersion Normalized PMF. Yunle Chen, David Q. Rich, PHILIP K. HOPKE, *University of Rochester*

Since Clean Air Act regulation in the 1970's, a variety of efforts have been made in the United States to control ambient particulate matters and to improve air quality. In the New York State, some major changes made to improve air quality in the past decade include but not limited to the phasing out of all coal-fired power plants, a forced abandonment of No 6 oil for large building heating, a forced switch to ultra-low sulfur marine fuels, the introduction of Tier 3 light-duty vehicles, etc. In this study, we investigated the PM5 source trends at 11 sites in New York and New Jersey from 2010 to 2019 and assessed the effectiveness of policy implementations. Dispersion-normalized positive matrix factorization (DN-PMF) was used for source apportionment to better address the meteorological impacts. The Theil-Sen nonparametric estimator and piecewise linear regression were applied to the resolved source contributions for trend analysis. It is found that, while there is a consistent overall decreasing of PM2.5 at all sites, increases were observed for certain PM sources. The Secondary Sulfate factor, for example, started to increase after 2017 at most sites based on piecewise analysis. Similarly, a recent-year increase was resolved for Diesel factor likely due to increasing vehicle miles traveled for heavy-duty vehicles. Back trajectory analysis traced back OP-Rich source to Southeastern U.S., while Biomass Burning has a mixed source from both local domestic heating and transported from Southeastern U.S.

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10AC.1

HPALD2 is a Peroxyhemiacetal and a Source of SOA. REBECCA RICE, Jason Surratt, Zhenfa Zhang, Avram Gold, *University of North Carolina at Chapel Hill*

Isoprene, a volatile organic compound (VOC) is emitted largely by vegetation at a rate of 512 Tg/yr. Based on theoretical calculations and mass spectrometric evidence, Z-δ-hydroperoxyalkenal structures (HPALD1 and HPALD2) have been assigned to $C_5H_8O_3$ gas-phase compounds accounting for up to 12% of the total first-generation isoprene oxidation products. The putative HPALDs are conjugated carbonyls expected to have a significant absorption cross section at ambient UV wavelengths (> 315 nm). Fast internal energy transfer from the excited alkenal to the O-OH bond is predicted to cause rapid bond dissociation degradation into volatile fragments, with little or no formation of SOA.

We undertook synthesis of HPALD2 to verify the structure assigned solely from mass spectrometry. By proton NMR, HPALD2 exists exclusively as the peroxyhemiacetal tautomer, with no carbonyl detected, even in D_2O. Tautomerization to the cyclic peroxyhemiacetal is strongly favored by the Z geometry of HPALD2. The peroxyhemiacetal structure of the isoprene photochemical oxidation product was confirmed by matching the IMS drift time of the synthetic standard with a major $C_5H_8O_3$ product from hydroxyl radical oxidation of isoprene.

Lacking the conjugated chromophore, the peroxyhemiacetal does not absorb at > 250 nm will persist at ambient UV wavelengths. In chamber experiments, OH oxidation caused rapid nucleation in the absence of seed, and reactive uptake in the presence of both $(NH_4)_2SO_4$ and $(NH_4)HSO_4$ seed. Products at m/z $C_5H_8O_5$, $C_5H_{10}O_5$, $C_5H_{10}O_6$ were detected by on-line monitoring of the gas phase by an iodide-CIMS-high resolution time-of-flight mass spectrometer (HR-ToF-MS). Analysis of filter extracts by hydrophilic interaction liquid chromatography coupled to an electrospray ionization HR-ToF-MS detector operated in the negative mode showed major products with compositions $C_5H_{10}O_5$ in all experiments, and major sulfated products with compositions $C_5H_{10}O_8S$ and $C_3H_6O_6S$ in seeded experiments.

10AC.2

Chemical Composition of Secondary Organic Aerosol Formed from the Oxidation of Isoprene-Derived C5H10O3 Reactive Uptake Products. MOLLY FRAUENHEIM, Jason Surratt, Zhenfa Zhang, Avram Gold, *University of North Carolina at Chapel Hill*

Isoprene, the largest non-methane volatile organic species emitted into Earth's atmosphere, reacts with hydroxyl radicals to initiate formation of secondary organic aerosol (SOA). Under low nitric oxide conditions, the major oxidative pathway proceeds through acid catalyzed reactive uptake of isoprene-epoxydiol isomers (IEPOX). We have recently established the structures of the semivolatile C5H10O3 uptake products (formerly designated "C5-alkene triols) of cis- and trans-β-IEPOX as 3-methylenebutane-1,2,4-triol and isomeric 3-methyltetrahydrofuran-2,4-diols. Importantly, both uptake products showed significant partitioning into the gas phase. Here, we report evidence that the uptake products along with their gas phase oxidation products constitute a hitherto unrecognized source of SOA. We show that partitioning into the gas phase results in further oxidation into low volatility products, including highly oxygenated C5-polyols, organosulfates, and dimers. In the chamber studies, gas phase products were characterized by online by iodide-Chemical Ionization Mass Spectrometry (I-CIMS) and particle phase products by offline analysis of filter extracts by HILIC/(-)ESI-HR-QTOFMS using authentic standards. The chamber studies show the potential for a substantial contribution to SOA from reactive uptake of the second generation gas phase oxidation products onto both acidified and non-acidified ammonium bisulfate seed aerosols. Identification of these previously unrecognized early-generation oxidation products will improve estimates of atmospheric carbon distribution and advance our understanding of the fate of isoprene oxidation products in the atmosphere.

10AC.3

Non-Equilibrium Behavior in Fresh Isoprene Secondary Organic Aerosol. Yuzhi Chen, Rahul Zaveri, Gregory W. Vandergrift, Zezhen Cheng, Swarup China, Alla Zelenyuk, JOHN SHILLING, *Pacific Northwest National Laboratory*

Recent studies have shown that instantaneous gas-particle equilibrium partitioning assumption fails to predict SOA formation, even at high relative humidity (~85%), and aging seems to be a driving factor. In this study, we probed the minimum aging timescale required to observe non-equilibrium partitioning of semivolatile organic compounds (SVOCs) between the gas- and aerosol-phase at ~50% RH. Seed isoprene SOA was generated by photo-oxidation in the presence of effloresced ammonium sulfate seeds at <1ppbv NOx, aged photochemically or in the dark for 0.3–6 hours, and subsequently exposed to fresh isoprene SVOCs. Our results show that the equilibrium partitioning assumption is accurate for fresh isoprene SOA but breaks down after isoprene SOA has been aged for as short as 20 minutes, even in the dark. Modeling results showed that a semi-solid SOA phase state was necessary to reproduce the observed particle size distribution evolution. The observed non-equilibrium partitioning behavior and inferred semi-solid phase state were corroborated by offline mass spectrometric analysis on the bulk aerosol particles showing the formation of organosulfates and oligomers. The unexpected short timescale for phase transition within isoprene SOA has important implications for the growth of atmospheric ultrafine particles to climate-relevant sizes.

10AC.4

Decreases in Epoxide-Driven Secondary Organic Aerosol Production under Highly Acidic Conditions: The Importance of Acid-Base Equilibria. Madeline Cooke, N. Cazimir Armstrong, Alison Fankhauser, Yuzhi Chen, Ziying Lei, Yue Zhang, Isabel Ledsky, Barbara Turpin, Zhenfa Zhang, Avram Gold, V. Faye McNeill, Jason Surratt, ANDREW AULT, *University of Michigan*

Organic aerosol (OA) is ubiquitous globally, with a majority formed through secondary processes (SOA). Isoprene has the highest emissions to the atmosphere of any non-methane hydrocarbon, and isoprene epoxydiols (IEPOX) are well-established oxidation products and the primary reaction pathway forming isoprene-derived SOA. Highly acidic particles (pH 0-3), widespread across the lower troposphere, enable acid-driven multiphase chemistry of IEPOX, such as epoxide ring-opening reactions leading to organosulfate and polyol formation in fine particles. Herein, we systematically demonstrate an unexpected decrease in SOA formation from IEPOX on highly acidic particles (pH < 1). After reactive uptake, IEPOX undergoes nucleophilic attack by sulfate (SO_4^{2-}) to form methyltetrol sulfates and H_2O to form 2-methyltetrols. While SOA formation is commonly assumed to increase at low pH when more [H^+] is available to protonate epoxides, we observe maximum SOA formation at pH 1, and less SOA formation at pH 0.0 and 0.4. Lower SOA formation is attributed to limited availability of SO_4^{2-} at pH values below the acid dissociation constant (pK_a) of SO_4^{2-} and bisulfate (HSO_4^-). The nucleophilicity of HSO_4^- is 100× lower than SO_4^{2-}, decreasing SOA formation and shifting the products from organosulfates to polyols based on HILIC/ESI-HR-QTOFMS. The observed sulfate-limited regime (pH ≤ 0.4) is difficult to replicate with thermodynamic and mechanistically-focused atmospheric models due to high aerosol ionic strengths (> 12 moles/kg), and the SO_4^{2-}/HSO_4^- equilibrium. Accounting for this underexplored acidity-dependent behavior is critical for accurately predicting SOA concentrations and resolving the impacts of SOA-driven poor air quality in many regions globally.

10AC.5

Studies of Isoprene SOA Formation Under Atmospherically-Relevant RO2 Conditions. NADIA TAHSINI, Hannah Kenagy, Matthew Goss, Yaowei Li, Frank Keutsch, Jesse Kroll, *MIT*

Isoprene is an important SOA precursor in the atmosphere, and thus the yields and composition of isoprene SOA have been major targets of past laboratory chamber studies. However, most such studies were carried out under very high-NO or very low-NO conditions, with short peroxy radical (RO_2) lifetimes. As a result, the RO_2 fate, including both bimolecular processes and isomerization reactions, is not representative of the fate in the real atmosphere, likely affecting product distributions and the formation of SOA.

Here, we access a range of atmospherically-relevant RO_2 conditions—including long RO_2 lifetimes and moderate NO levels—in a laboratory chamber to investigate gas-phase composition and SOA formation from OH-initiated isoprene oxidation. Gas-phase species are characterized with an ammonium chemical ionization mass spectrometer (NH_4^+-CIMS) and a proton transfer reaction mass spectrometer (PTR-MS). For the particle-phase, an aerosol mass spectrometer (AMS) is used to characterize the amount and composition of aerosol formed. RO_2 reaction pathways and lifetimes are assessed using both measurement of oxidation products and mechanistic modeling. Results from this study include gas-phase product composition, SOA yields, and SOA oxidation state, all as a function of RO_2 conditions.

10AC.6

Investigating the Heterogeneous Formation and Degradation of Oligomers in Isoprene Epoxydiol-Derived Secondary Organic Aerosol. CARA WATERS, Katherine Kolozsvari, Jin Yan, Madeline Cooke, Alison Fankhauser, N. Cazimir Armstrong, Rebecca Parham, Yao Xiao, Carlie Poworoznek, Zhenfa Zhang, Avram Gold, Jason Surratt, Andrew Ault, *University of Michigan*

Secondary organic aerosol (SOA) is composed of a significant fraction of low-volatility high-molecular-weight oligomer products. These species can affect particle viscosity, morphology, and mixing timescales, yet they are not very well understood. While strides have been made in elucidating oligomer formation mechanisms, their degradation is less studied. Previous work suggests that the presence of oligomers may suppress particle mass loss during atmospheric aging by slowing the production high-volatility fragments from monomers. Our work investigates the effects of relative humidity (RH) on oligomer formation in SOA and the effects of hydroxyl radical (·OH) exposure on oligomer degradation. To probe these questions, SOA is generated by the reactive uptake of isoprene epoxydiols (IEPOX) onto acidic ammonium sulfate aerosol in a 2-m^3 steady-state chamber, followed by exposure to ·OH in an oxidation flow reactor. We investigate SOA formation at 30-80% RH, which is above and below the deliquescence point of ammonium sulfate. We examine the evolution of SOA bulk chemical composition as well as single-particle physicochemical properties over the course of aging using mass spectrometry-, spectroscopy-, and microscopy-based techniques. An optimized matrix-assisted laser desorption ionization mass spectrometry (MALDI-MS) method is used to identify and track the presence of oligomers in SOA over the course of aging. Our research will provide insight about the formation and degradation of oligomers in the atmosphere, which will allow better modeling of their impact on climate.

10ES.1

Biophysical Impacts of Aerosols on Terrestrial Climate. TC CHAKRABORTY, Xuhui Lee, Dave Lawrence, *Pacific Northwest National Laboratory*

Studies on aerosol impacts on the climate have traditionally focused more on changes in the atmospheric radiation budget. However, aerosols have a disproportionately higher impact on the Earth's surface, where humans reside. Here, we isolate the impacts of aerosols on the surface climate to better understand the mechanisms that modulate the overall climate response to aerosol loading by developing a surface energy budget perspective to aerosol-climate interactions. We first quantify the impact of aerosols on local temperature through both radiative and non-radiative pathways using a reanalysis dataset with assimilated aerosol observations from satellites. We find that the relative strengths of these pathways depend heavily on both aerosol and land surface properties. Then, to capture the impact of aerosols on surface climate through non-radiative pathways, a global land model was run with and without aerosols. In both cases (estimates from reanalysis and land model), a conceptual framework to attribute surface temperature anomalies to its determinants was used to examine the relative impact of each pathway on the local surface temperature. The associated impacts on terrestrial evapotranspiration and land carbon uptake through global dimming and diffuse radiation fertilization effect of aerosols were also quantified on a global scale using the land model runs. We demonstrate that aerosols can increase evaporative cooling over and land, with the strength of this pathway dependent on vegetation density. This work advances our understanding of the biophysical mechanisms through which aerosols can impact surface temperature, terrestrial evapotranspiration, and land carbon uptake. We will also provide an introductory perspective on the importance of the diffuse radiation fertilization effect and the current uncertainties in its representation in Earth System Models.

10ES.2

Exploring Toxic Cyanobacteria Blooms under Current and Future Environmental Conditions in the Great Lakes. REAGAN M ERRERA, Casey Godwin, Mark Rowe, Craig Stow, Steve Ruberg, Henry Vanderploeg, Andrea Vander Woude, Gregory Doucette, Richard Stumpf, Russ Miller, Gregory Dick, Benjamin Kramer, *NOAA-GLERL*

Traditionally coastal systems have been monitored using ship-based sampling methods, which provide a discrete spatial and temporal snapshot. These discrete events often miss key environmental shifts that lead to high variability in bloom biomass and toxin concentrations (e.g. 2014 Toledo Water Crisis). Understanding and interpreting the complex interactions between biological, chemical, and physical variables in coastal systems require versatile monitoring. To enhance our observational scale, I will discuss how NOAA is developing a monitoring network in Lake Erie to study cyanobacteria harmful algal blooms using traditional methods, emerging technologies, and exploring how cyanobacteria harmful algal blooms may change based on climate impacts. Weekly monitoring at discrete sampling sites provide a bases of environmental conditions. The extent of bloom biomass and phytoplankton functional groups is determined through daily satellite and weekly hyperspectral imaging. Paired with physical observations and modeling, bloom biomass and toxin concentration movement are forecasted up to 5 days in the future. Within the water column, real-time nutrient buoys and second generation (2G) Environmental Sample Processors (ESP) provided near-real time particulate microcystin concentrations. With colleagues at Monterey Bay Aquarium Research Institute (MBARI) has we have tested a 3rd Generation (3G) ESP, an autonomous molecular diagnostic device capable of collecting eDNA, embedded in an uncrewed vessel with the capacity for near real-time toxin (e.g., microcystin) analysis using an embedded Surface Plasmon Resonance (SPR) instrument. Finally, field and lab-based experiments consider bloom initiation triggers, the role of inorganic carbon, resuspension events, cell buoyancy, and community dynamics on bloom development. This complex network of temporal and spatial environmental data then provided to the scientific community, managers, and public stakeholders to support decision making and enhance our understanding of bloom succession.

10ES.3

Volcanic Ash and Dust Induce Differing Responses in Marine Phosphorus Cycling Depending on the Deposition Amount. CASSANDRA GASTON, Hope Elliott, Kimberly Popendorf, Amanda Oehlert, Arash Sharifi, Edmund Blades, Haley Royer, Clement Pollier, Ali Pourmand, Andrew Ault, Swarup China, Nurun Nahar Lata, Zezhen Cheng, Ravi Kukkadapu, Mark Bowden, Mark Engelhard, Adrian Hornby, Esteban Gazel, *University of Miami*

Aerosols deposit both nutrients as well as toxins that stimulate (or inhibit) the productivity of marine biota, impacting carbon sequestration in the ocean. African dust is traditionally thought to be the most important, continuous supply of nutrients to the open North Atlantic Ocean, and this supply is well documented by an over 50-year dust time series from the Ragged Point measurement facility in Barbados. However, the impact of other aerosol sources as well as extreme events such as major dust storms on marine biogeochemical cycles remains underexplored. Therefore, we investigated the impact of the 2020 Godzilla dust storm and 2021 volcanic eruption of La Soufriere on the island of St Vincent on marine phosphorus cycling and productivity. P is limiting in parts of the North Atlantic and can stimulate nitrogen fixation in tandem with increased iron (Fe) inputs, especially in the low latitude N. Atlantic Ocean. Incubations were conducted at low and high deposition of dust and volcanic ash. Despite much lower P solubility in volcanic ash compared to Godzilla dust, the addition of both aerosol types stimulates P cycling and increased P uptake rates. However, high ash deposition induces reduced P uptake rates and slowed P cycling times, highlighting that not all aerosol deposition events are beneficial for marine biota. Bulk elemental and single particle analysis combined with elemental mapping reveals the presence of surficial Fe hot spots on volcanic ash particles not present on dust in addition to a wider suite of trace elements (Mn, Co) important for biological function. Our results highlight that both the source and amount of aerosol deposited determines the biological outcome of deposition events.

10ES.4

Ice-nucleating Particle Characteristics and Relation to Bioaerosols in Air and in Precipitation at a Semi-arid Grassland Site. Claudia Mignani, PAUL DEMOTT, Thomas C. J. Hill, Marina Nieto-Caballero, Noelle Bryan, Alexei Kiselev, Nurun Nahar Lata, Swarup China, Teresa Feldman, Chamari Mampage, Kathryn Moore, Amy P. Sullivan, Ben Ascher, Nick Falk, Sean Freeman, Gabrielle Leung, Allie Mazurek, Christine Neumaier, Thomas Leisner, Susan van den Heever, Leah Grant, Elizabeth Stone, Russell Perkins, Sonia Kreidenweis, et al., *Colorado State University*

Biological ice-nucleating particles (INPs) are released into the atmosphere from soils, water, and plants. This subset of bioaerosols catalyze the formation of ice in clouds at temperatures modestly below 0°C. Precipitation-stimulated release is a mechanism observed in many ecosystems. Here, we seek to understand this process using observations at the National Science Foundation (NSF) National Ecological Observing Network Central Plains Experimental Range, a semi-arid shortgrass site in Northeast Colorado. The CPER site is representative of regions of the North American Great Plains, an area that experiences episodes of severe weather, including heavy rain, large hail, and strong, low-level winds associated with convective cold pools.

We present results from collaborative studies of the BioAerosol and Convective Storms Phase I (BACS-I) campaign and the NSF Biology Integration Institute Regional OneHealth Aerobiome Discovery Network (BROADN), occurring from May 23 to June 17, 2022. Together, these studies examined environmental and storm-related bioaerosol release and feedbacks of bioaerosols on storm development. A Wideband Integrated Bioaerosol Sensor was run continuously to measure fluorescent aerosol particles, and those observations indicated that precipitation, air mass boundary passages, and relative humidity cycles influenced the abundance of fluorescent biological aerosol particle types. Rain was collected during three events. Aerosol particles were sampled before, during and after rain events with a high-volume filter sampler, polycarbonate filters and a size-resolved impactor. Filters and precipitation samples were processed to measure and compare the atmospheric and within-precipitation concentrations of INPs. INP concentrations in precipitation are consistent with INP concentrations in air measured prior to precipitation events. Enhancement of biological INPs in air is noted following precipitation. Scanning electron microscopy (SEM) techniques are used to determine the chemical composition and morphology of single particles and, via environmental-SEM, INPs. Future studies will link amplicon and metagenomic sequencing to bioaerosol and INP responses to precipitation.

10ES.5

Comparative Assessment of Bioaerosol Fluorescence, Microbial Communities, and Ice Nucleating Particle Abundance During Strong Relative Humidity Shifts in Colorado Grasslands. MARINA NIETO-CABALLERO, Noelle Bryan, Claudia Mignani, Thomas C. J. Hill, Kevin R. Barry, Brian Heffernan, Teresa Feldman, Chamari Mampage, Ben Ascher, Jacob Escobedo, Nick Falk, Sean Freeman, Gabrielle Leung, Allie Mazurek, Christine Neumaier, Daniel Veloso-Aguila, Jessie Creamean, Susan van den Heever, Elizabeth Stone, Leah Grant, Russell Perkins, Paul DeMott, Sonia Kreidenweis, *Colorado State University*

Aerosol particles of biological origin have been described as key agents in atmospheric processes; however, microbial communities, size distributions, abundance of atmospheric bioaerosols, and their relationship with atmospheric processes are still largely unknown. In this study, part of the NSF BROADN project (Bii Regional OneHealth Aerobiome Discovery Network), we evaluate the relationship between significant relative humidity (RH) shifts during diurnal cycles and their effects on different bioaerosol components, such as microbial composition (*i.e.*, 16S rRNA and ITS gene markers), ice nucleating potential, fluorescence properties, and size distributions during high and low relative humidity (RH) periods (*i.e.*, ΔRH = 53.23% ± 6.18). This study was performed in May-June of 2022 at the Semi-arid Grasslands Research Center (SGRC, Colorado), representative of the North American Great Plains, by studying bioaerosol composition during diurnal RH shifts with an average high RH of 80.37% ± 9.65 and an average low RH of 27.14% ± 11.17.

Preliminary WIBS-NEO (Wideband Integrated Bioaerosol Sensor NEO) results show an increase in fluorescent particles during high RH periods, pointing towards increased concentrations of biological particles and shifts in particle size distributions. Unexpectedly, given the changes in fluorescence profile, 16S rRNA results show that bacterial community composition of bioaerosols, collected with a SASS 3100 (Research International) at 300 Lpm, are not significantly different during high and low RH levels (UniFrac PERMANOVA p-value > 0.05). Although these differences are not evident for bacterial bioaerosols, we hypothesize that airborne fungal community composition, as well as ice nucleating particle (INP) abundance, will show differences during high and low RH levels of diurnal cycles (work in progress). More specifically, we expect fungal taxa community shifts and an increase in biological INP concentrations during night periods (*i.e.*, high RH).

10ES.6

Characterizing Bioaerosols during Quiescent and Convective Conditions in a Grassland Environment. TERESA FELDMAN, Chamari Mampage, Claudia Mignani, Marina Nieto-Caballero, Thomas C. J. Hill, Brian Heffernan, Christine Neumaier, Ben Ascher, Jacob Escobedo, Nick Falk, Sean Freeman, Gabrielle Leung, Allie Mazurek, Daniel Veloso-Aguila, Noelle Bryan, Leah Grant, Susan van den Heever, Russell Perkins, Paul DeMott, Sonia Kreidenweis, Elizabeth Stone, *University of Iowa*

Bioaerosols can impact public health through potential loading of allergens and toxins, as well as weather and climate, by acting as cloud condensation nuclei and ice nucleating particles. Additionally, their properties and effects can be altered in the atmosphere, such as by the rupturing of pollen in high humidity environments to release pollen fragments, subsequently enhancing the sites of cloud water and ice crystal nucleation. To study and describe potential interactions and feedbacks between bioaerosols and convective storms, we characterize bioaerosols based on their size distributions, concentrations, and using chemical tracers during quiescent and convective conditions in the first BioAerosol and Convective Storms field campaign (BACS-I). Samples were collected from May 23-June 17, 2022, at the Central Plains Experimental Range, a National Science Foundation National Ecological Observatory Network site in Northeastern Colorado. Ground based samples were collected using high flow impactors and a rainwater collector to be analyzed for chemical tracers of pollen, fungal spores, and bacteria, as well as with a Burkard spore trap for identification and concentrations of pollen using light microscopy. A Wideband Integrated Bioaerosol Sensor (WIBS-NEO), a single particle fluorescence spectrometer, was used to measure concentrations of fluorescent particles as a proxy for bioaerosols with high time resolution. These data reveal large variability in the response of fluorescent particles to the passage of cold pools, which are negatively buoyant regions of cold air associated with precipitating convective storms. Through complementary analysis of the highly time-resolved WIBS data with offline analysis of chemical tracers, a comprehensive investigation of bioaerosols during convective storms in a grassland environment will be presented. Understanding these impacts will improve modeling of bioaerosol feedbacks on weather and climate, as well as predictions of potential health impacts.

10IA.1

Indoor Organic Aerosol Formation Near Building Occupants Using Computational Fluid Dynamics. SUWHAN YEE, Donghyun Rim, *Pennsylvania State University*

Several studies have developed chemical reaction models for secondary organic aerosol formation. The volatility basis set model is one of the methods that estimate the amount of aerosol formed from the total organic material. However, only a few studies focused on the spatial gradient of secondary organic aerosols near indoor occupants, as the volatility basis model assumes a well-mixed model. This study aims to investigate indoor aerosol formation due to indoor temperature gradients near humans and determine the effects of cooling, heating, and ventilation on indoor aerosol concentration. Computational fluid dynamics (CFD) simulation combined with two-dimensional volatility basis set (2D-VBS) model is used to demonstrate indoor aerosol formation from organic materials from outdoors. The 2D-VBS model used six different volatility bins for the outdoor organic materials. The indoor temperature gradient is calculated using CFD simulation, and the aerosol mass fraction is calculated for each volatility bin to predict the mass of aerosol formed indoors. Ventilation strategies are evaluated using the room average value of aerosol mass concentration and the concentration near the breathing zone. The simulation results show that the organic aerosol's mass concentration can vary due to different ventilation conditions. Especially the aerosol concentration tends to be lower with lower air exchange rates. Also, the aerosol concentrations near the breathing zone varied due to the occupant's position with respect to the air supply inlet. The study results indicate that the indoor organic particle concentration notably varies with cooling and heating conditions.

10IA.2

Understanding the Reduction of Indoor PM2.5 Emissions by Using the Two-Dimensional Nature of Wood Pyrolysis. JOHN FLYNN, Tami Bond, *Colorado State University*

Indoor air pollution remains a challenge for many worldwide. A major contributing source of PM2.5 indoors is the use of wood burning stoves which use large pieces of wood fuel with inefficient burning. When starting and operating a cookfire the first and unavoidable stage is the pyrolysis stage. This stage, which proceeds flaming combustion, has been shown to contribute the majority of PM2.5 emission during the combustion process. One solution to reducing these emissions lies in a more rapid transition from pyrolysis to flaming combustion. Technologies have been developed in stove design communities to improve combustion emissions; however, many households across the globe face financial hurdles preventing them from acquiring this technology. Although advanced stove technology can improve fuel emissions, the transition from pyrolysis to sustained combustion through more rapid ignition also acts to reduce PM2.5 ejection from the wood fuel. Our approach involves reduction of PM2.5 emissions by identifying fuel preparation techniques that serve to cause ignition to occur quickly during the initial transient stage of burning. These techniques are rooted in heat and mass transfer concepts, foremost of which is termed ‘critical mass flux’. We show how modifying wood fuel to expose end grain surface area leads to achieving the critical mass flux required to decrease time to ignition. We take advantage of the naturally occurring two-dimensional heat and mass transfer to better suit the budgets of families in developing countries. The best part: it’s free.

10IA.3

Indoor Air Pollution in an Academic Institution: PM Levels, Chemical Composition, and Possible Health Impact.

DEBAYAN MANDAL, Abhishek Chakraborty, Shruti Tripathi, *Indian Institute of Technology Bombay*

As 21st-century humans, we spend 85-90% of our time indoors. Historically ambient air pollution got more attention from researchers worldwide. But indoor air pollution is more important from a health perspective. This study measured indoor pollution in a dry laboratory, residential room, and dining hall of a residential academic institute in Mumbai, India. Concentrations of PM_{10} , $PM_{2.5}$ and PM_1 are maximum in window open AC off condition in the laboratory . $PM_{2.5}$ concentration, i.e.28.05±15.02 µg/m^3 exceeded the WHO prescribed limit for 24 hours. The particle concentration is least in window closed ac on condition. PM_{10}, $PM_{2.5}$ and PM_1 concentrations are 8.05±2.54, 7.01±1.05 and 6.49±1.22 µg/m^3, respectively, which is 413%, 309%, and 224% lower than window open ac off conditions. The indoor-to-outdoor ratio (I/O) is always less than 1 in this microenvironment, indicating the primary source of indoor particles is the infiltration of particles from outdoors. In the single occupancy residential room, the $PM_{2.5}$ concentration violates WHO standards during morning and evening activity (non-cooking/smoking) hours. $PM_{2.5}$ is highest in the dining hall adjacent to the kitchen, i.e., 124.62 ±62.24 µg/m^3. The I/O is greater than 1 all the time in this microenvironment. The IMPROVE method finds four Organic Carbon (OC) fractions and 3 different elemental carbon (EC) fractions on the quartz fiber filters collected from the microenvironments. All the fractions are lesser in the laboratory environment than corresponding outdoor. But the fractions are higher in the other two indoor microenvironments than the corresponding outdoors. EDXRF was used to figure out the elemental composition. The obtained metal concentrations are used to determine hazard risk (HR) and cancer risks (CR). Surprisingly, the residential room is marginally prone to cancer risk ($CR > 1*10^{-4}$) via inhalation; however, no active biomass burning source like cooking and smoking was present there.

10IA.4

Insights into Low-Cost Particle Sensors Using Size-Resolved Scattering Intensity of Indoor Aerosols.

ALOK KUMAR THAKUR, Jonathan Gingrich, Marina Vance, Sameer Patel, *Indian Institute of Technology Gandhinagar*

Spatio-temporal air quality measurements, both ambient and indoor, are critical to understanding emissions sources and their profile to develop effective mitigation strategies. However, deploying multiple units of research-grade instruments to capture spatiotemporal trends can be cost-prohibitive. In recent years, cost-effective, compact, and portable low-cost air quality sensors have gained impetus for high spatial-temporal resolution measurements.

The low-cost PM sensors measure light scattering and provide an analog output (usually a voltage signal) or digital output in the form of mass concentrations based on calibrations. Low-cost sensor outputs are influenced by the particle’s physical properties, such as refractive index and size distribution. Calibrating low-cost sensors by collocating them with reference instruments is widely accepted to increase the reliability of low-cost sensor measurements. However, such calibrations are limited in terms of the type and size (or size distribution) of aerosols it can be applied to.

Different cooking experiments were performed in a test house, and the indoor PM concentration was measured using a low-cost sensor (Plantower) and reference instruments (SMPS+APS). Ultrafine particles constituted as high as 95% of total PM mass concentration during certain cooking activities. As per the manufacturer, the low-cost sensors are unsuitable for sub-300 nm PM. However, the low-cost sensor can detect cumulative scattering from high concentrations of ultrafine particles.

Firstly, correlations were checked between mass concentrations measured by the low-cost sensor and the reference instruments. Then correlations between scattering intensity (calculated using size-resolved data from the reference instruments and low-cost sensor characteristics) and mass concentration measured by low-cost sensors were checked. In addition to mass concentrations, size-resolved number concentrations reported by the low-cost sensors were also compared with that from the reference instruments. The analysis provides insights into the suitability of low-cost sensors for indoor measurements.

10IA.5

Characterizing the Impact of Different Environments (Indoor and Outdoor) on the Performance of Low-cost Particulate Matter (PM) Sensors. SABRINA WESTGATE, Zahra Shivji, Nga Lee Ng, *Georgia Institute of Technology*

As the availability of low-cost sensors has progressively increased over the past years, so too has the importance of characterizing and quantifying low-cost sensor measurement capabilities. There is a particular need to assess how low-cost sensors perform during in-situ monitoring in different environments. Towards this end, in this study we compared the particulate matter (PM) data reported by two low-cost sensors (PurpleAir and QuantAQ MODULAIR-PM) in both outdoor and indoor environments on the Georgia Tech Campus. The PurpleAir sensor consists of a Plantower PMS nephelometer and reports PM_1, $PM_{2.5}$, and PM_{10}, while the QuantAQ sensor combines an AlphaSense optical particle counter (OPC) as well as a Plantower PMS nephelometer to report size-resolved particle mass concentration of PM_1, $PM_{2.5}$, and PM_{10}. To assess sensor performance, low-cost sensor data were analyzed for various environments including outdoors (urban Atlanta), in a classroom, in an academic common space, and in a cafeteria. Measurements both indoors and outdoors were also compared to measurements from a Scanning Mobility Particle Sizer (SMPS). To investigate the effects of aerosol composition on sensor performance, sensor data collected outdoors were compared to data from the Aerosol Chemical Speciation Monitor (ACSM). Both types of sensors generally agreed with research-grade instruments in the outdoor measurements. However, aerosol composition, as well as mass loading and aerosol size distribution, impacted sensor performance and agreement. Results also indicated that the Plantower sensor misses much of the PM mass in certain environments, such as when there are large particle events (particles >1 micron in diameter) and in a university classroom where PM mass concentrations are often below the limit of detection. Results from this study provide data-driven insights into what types of environments different sensor types are best suited for, and under what aerosol conditions they face the most limitations.

10IA.6

Low-Cost Indoor Sensor Deployment for Predicting PM2.5 Exposure. SHAHAR TSAMERET, Jiayu Li, Daniel Furuta, Albert Presto, Provat Saha, *University of Miami*

Indoor air quality is critical to human health, as individuals spend 90% of their time indoors. Specifically, particulate matter (PM) is associated with several adverse health outcomes. However, indoor PM networks are not studied as often as outdoor networks. In this study, indoor PM2.5 exposure is investigated via 2 low-cost sensor networks in Pittsburgh. The first network contains 21 real-time, affordable, multi-pollutant sensors (RAMPS) outfitted with PurpleAir PM sensors. The second network includes 16 PurpleAir sensors reporting PM concentrations on the PurpleAir map. The concentrations reported by the networks were fed into a Monte Carlo simulation to predict daily PM2.5 exposure for 4 demographics (indoor workers, outdoor workers, schoolchildren, and retirees). Additionally, this study compares correction factor effects on reported concentrations from the PurpleAir sensors. The results of the Monte Carlo simulation show that mean PM2.5 exposure varied by 1.5 µg/m3 or less when indoor and outdoor concentrations were similar. When indoor PM concentrations were lower than outdoor, increasing the time spent outdoors increased exposure by up to 3 µg/m3. This analysis explores how individual schedules affect PM2.5 exposure and explores the effect of correction factors on a low-cost indoor sensor network.

10ID.1

Gas Composition and Humidity Affect the Stability of Enveloped Viruses. ALEXANDRA LONGEST, Rania Smeltz, Nisha Duggal, Linsey Marr, *Virginia Tech*

Respiratory viruses, such as influenza, RSV, and SARS-CoV-2, spread through the air and cause major strain on medical systems throughout the world. Research has shown that environmental stability of these viruses in aerosols and droplets can be influenced by many factors, including temperature, relative humidity, physico-chemical properties of droplets, and virus strain, but the mechanism of inactivation of viruses is unknown. One hypothesis is that a change in pH in the droplets, due to CO2 or other trace gases in the atmosphere, damages the virus. Another is that reactive oxygen species in the air partition into droplets and cause damage. The objective of this study was to determine the effect of different atmospheres (ambient air versus nitrogen) and RH (27, 55, and 82%) on the stability of two enveloped viruses: bacteriophage Phi6 and influenza A virus in 1 µL droplets over 4 hours. Phi6 was a surrogate used first to establish methodology and preliminary results. At low RH, there was no difference in decay between atmospheres. At mid and high RHs, there was significantly more decay at certain times (2,4 and 4 hours, respectively) in ambient air versus nitrogen. This experiment has been extended to a seasonal influenza virus (H1N1pdm09). Overall, this study suggests that the composition of the surrounding gas affects inactivation of viruses in droplets, and that droplet evaporation, mediated by RH, has an impact as well. Understanding the drivers of virus inactivation is important in developing interventions for reducing transmission of respiratory viruses.

10ID.2

Ambient Concentrations of CO2(g) Affects the Aero-Stability of SARS-CoV-2. ALLEN E. HADDRELL, Henry Oswin, Tristan Cogan, Joshua Robinson, Jianghan Tian, Robert Alexander, Jamie Mann, Darryl Hill, Adam Finn, Andrew Davidson, Jonathan P. Reid, *University of Bristol*

The length of time that SARS-CoV-2 remains infectious while suspended in the aerosol phase will affect its overall spread. Thus, a detailed mechanistic understanding of how infectious viral particles lose infectivity in the aerosol phase is critical in predicting viral degradation across a broad range of environmental conditions.

It has been recently demonstrated that the high alkalinity a respiratory aerosol reaches immediately after exhalation (pH>10) is caustic enough to irreversibly inactivate SARS-CoV-2(1). The high pH reached by the aerosol results from the massive flux of dissolved bicarbonate from the droplet in the form of CO2(g):

Eq1. $H^+ + HCO_3^- \leftrightarrow H_2CO_3 \leftrightarrow CO_2(g) + H_2O$

The peak pH the aerosol reaches is functions of many factors, such acidic gases/vapours (including CO2(g)) and aerosol size.

In this study, next generation bioaeorol technology (CELEBS) is used to explore the buffering effect that ambient concentrations of CO2(g) (<3,000 ppm) have on the aero-stability of the Delta and Omicron variants of SARS-CoV-2.

Under ambient conditions, the Omicron variant was found to be significantly more aero-stable than the Delta variant. The increase in aero-stability correlates with the variants alkalinity sensitivity.

At a high relative humidity, any excess concentration of CO2(g) is found to improve the aero-stability of SARS-CoV-2 in a dose dependent fashion. Increases in the concentration of CO2(g) improved viral aero-stability across the entire relative humidity range. Elevated levels of CO2(g) reduces the rate in which SARS-CoV-2 loses infectivity in the aerosol phase; after 40 minutes, elevated CO2(g) resulted in an order of magnitude increase in infectious load. The consequence of this change in viral aero-stability on the risk of transmission is estimated with a Wells-Riley model.

[1] Oswin, H. et al., (2022)PNAS, 119(27), e2200109119.

10ID.3

Persistence of Phi6, a SARS-CoV-2 Surrogate, in Simulated Indoor Environments: Effects of Humidity and Material Moisture Adsorption. ELOISE PARRY-NWEYE, Zhenlei Liu, Yousr Dhaouadi, Xin Guo, Jianshun Zhang, Dacheng Ren, *Syracuse University*

The COVID-19 pandemic brought major challenges to public health and is primarily transmitted via aerosols, droplets, and fomites. However, there is a lack of understanding of virus persistence on fomites under different environmental conditions in a realistic environment. Thus, we aimed to bridge this knowledge gap especially as fomites are a significant virus transmission route. This study utilized *Phi6*, an 85 nm enveloped dsRNA bacteria virus, as a coronavirus surrogate due to its structural similarities. The experiments were conducted in a full-scale aerobiology chamber to simulate a realistic indoor environment. The viral titers were quantified via plaque assays and Reverse Transcription quantitative Polymerase Chain Reaction (RT-qPCR), which quantify the infective viral load and total viral load respectively. We initially assessed the effect of our sampling methods on the viability and integrity of aerosolized *Phi6* to validate the observed humidity-induced inactivation. Our results show that the infectivity of aerosolized *Phi6* decreases by ≥ 1-log as the Absolute Humidity (AH) increases from 5.6 $g.m^{-3}$ to 9.2 $g.m^{-3}$ to 17.4 $g.m^{-3}$ and then increases by ≥ 1-log as the AH increases to 19.5 $g.m^{-3}$. The kinetics of the humidity-induced inactivation shows that the decay rate of infectivity changed in the order (high to low) at 17.4 $g.m^{-3}$ > 5.6 $g.m^{-3}$ ≈ 9.2 $g.m^{-3}$ ≈ 19.5 $g.m^{-3}$. Consequently, we show that although material properties may impact virus persistence, however, local humidity at the air-substrate interface more significantly influences virus persistence. In addition, we show postulated changes in the aerosol pH and how these changes would affect the aerosolized virus. These results provide more insights into indoor viral transmission under varied environmental conditions. These findings will help the design of more effective strategies for viral control in indoor environments.

10ID.4

Determination of Bipolar Ionization-Mediated Airborne Virus Inactivation Rates. DARRYL ANGEL, Jordan Peccia, *Yale University*

Reducing the concentration of infectious viral aerosols within indoor settings is essential for decreasing infectious risk. Common airborne virus concentration reduction approaches, including outdoor air ventilation, HVAC (heating, ventilation, and air conditioning) system filtration, and in-duct ultraviolet germicidal irradiation are limited by the air exchange rates that can be achieved in a building. Similar to drinking water treatment, directly disinfecting a building's bulk air with a non-toxic disinfectant is a more effective strategy for reducing airborne infection. Bipolar ionization (BPI) is a currently utilized building bulk-air disinfection technology with the potential to reduce airborne virus concentrations through two proposed mechanisms: facilitating particle agglomeration to increase virus deposition onto building surfaces, and loss of viral infectivity caused by ion-induced damage to viral surface proteins. We determined bipolar ionization-mediated first order inactivation rate coefficients for aerosolized bacteriophage Phi6, a common surrogate organism for SARS-CoV-2. At ~49% relative humidity (RH), the total (0.15 1/min to 0.22 1/min; $p<0.01$) and infectious (0.31 1/min to 0.50 1/min; $p<0.01$) Phi6 decay rate coefficients increased when average bipolar ion exposure was increased from a baseline of 10^3 ions/cm^3 to experimental conditions of 10^6 ions/cm^3. The same significant increase ($p<0.01$) in total and infectious Phi6 decay was present at high (~76%) RH in the presence of additional bipolar ions. While we observed no difference between total Phi6 decay rates at low (~26%) RH ($p>0.05$) between the two bipolar ion concentrations, the inactivation of infectious Phi6 owing to BPI remained significant ($p<0.05$) but lower than the values measured under middle and high RH. Across all RH levels, the inactivation of infectious Phi6 attributable to BPI was greater than the natural decay of Phi6.

10ID.5

A Novel Approach to Understanding Viral Aerosol Stability.

ELIZABETH A. KLUG, Danielle N. Rivera, Don Collins, Ningjin Xu, Sean Kinahan, St. Patrick Reid, Daniel N. Ackerman, Ashley R. Ravnholdt, Vicki Herrera, Joshua L. Santarpia, *University of Nebraska Medical Center (UNMC)*

Viral diseases pose a significant risk to the general public. This is especially true of viruses that transmit as aerosols due to the potential for widespread disease transmission. These viral diseases may be transmitted from person-to-person, such as SARS-CoV-2, or as environmentally generated aerosols, like hantaviruses.

The threat a virus may pose as an aerosol depends on several factors, including its stability as an aerosol. Bioaerosol stability is generally studied as the decay of aerosol properties (viability/infectivity, detectability, etc.) in response to environmental conditions (sunlight, relative humidity, etc.). However, there is little understanding of how intrinsic viral properties drive this stability. To investigate and determine the aerosol and viral properties that drive the stability of viruses that infect humans as aerosols, we have developed a novel system and approach to the study of bioaerosol stability. The Biological Aerosol Reaction Chamber (Bio-ARC) is a flow-through system designed to rapidly expose biological aerosols to environmental conditions (ozone, simulated sunlight (UV), temperature, and humidity) and determine the sensitivity of those particles to simulated ambient conditions. Using this system, we examined the stability of a well-understood model organism: Bacteriophage MS2. In future work, we aim to better understand the key factors that determine viral stability and to better predict the stability of emerging viral diseases that pose a threat as an aerosol.

10ID.6

Effects of Chemically-reductive Gas Contaminants on Inactivation of Airborne Viruses by Non-thermal Plasma.

ZHENYU MA, Herek L. Clack, *University of Michigan*

Introduction: As the threats of airborne infectious disease outbreaks emerged worldwide, non-thermal plasma has the ability to control airborne virus transmission, whose inactivation effectiveness on bacteriophage MS2 has been verified by previous studies. However, the existence of chemically-reducing air pollutants from sources such as livestock may have a negative impact on the role of oxidizing species in the NTP inactivation process. In this study, ammonia and hydrogen sulfide were added to the airflow containing MS2 aerosols, and the inactivation efficiency of a packed-bed NTP device was tested. At the concentration level of 1 ppm, both NH_3 and H_2S have shown a statistically-negative impact on the NTP inactivation efficiency of MS2 virus.

Experimental Procedure: The experimental setup has been described in a previous literature[1]. The AC plasma power supply has a 20kV peak-to-peak voltage, at a 350Hz frequency. The aerosol has a <0.5s contact time with plasma, in an airflow of 200lpm. Viable virus concentrations are measured by a plaque assay. Physical losses are accounted for by repeating the test with plasma power-off.

Results: Without any trace gases, the packed-bed NTP has an inactivation efficiency of 1.04 log PFU per milliliter of sample (pfu/mL). Under such circumstances, the resulting plasma discharge power, calculated by integrating the monitored supply voltage and return current, was around 1.7W, suggesting a low required energy intensity.

A mass-flow controller is used for the addition of gas contaminants, whose concentration level was calibrated using a multi-gas sensor downstream of the NTP, with NTP off and viral aerosols not being generated. It is found that adding 1 ppm of NH_3 or H_2S lowers the level of MS2 inactivation to 0.48 and 0.51 logPFU/mL, correspondingly. Both NTP inactivation level drops were statistically significant, as each type of test was repeated at least five times.

Conclusions: Using a pack-bed NTP device and MS2 as the surrogate virus, we have found that the introduction of chemically-reducing air contaminants (such as NH_3, H_2S) may lower the virus inactivation efficiency of non-thermal plasma.

[1] Xia et al. (2019). Inactivation of airborne viruses using a packed bed non-thermal plasma reactor. Journal of physics D: Applied physics, 52(25), 255201.

10IM.1

Performance Characterization of an Aircraft Inlet for Aerosol-Gas Sampling. DA YANG, Rainer Volkamer, Lee Mauldin, Margarita Reza, Suresh Dhaniyala, *University of Colorado Boulder*

Aircraft-based measurements allow for large spatial-scale characterization of atmospheric aerosol and gas, but these measurements, under high-speed flow conditions, complicate efforts to maintain sample integrity through the inlet transport process. Of particular concern is the role of turbulence in driving loss of gas-phase species and aerosol particles. While a significant amount of research has gone into understanding aerosol sampling efficiency for aircraft inlets, a similar research investment has not been made for gas sampling. Here, we analyze the performance of a front-facing inlet as a function of operating conditions, including ambient pressure, freestream velocities, and sampling conditions. Using computational fluid dynamics (CFD) modeling, we simulate flow inside and outside the inlet to determine the extent of freestream turbulent interaction with the sample flow and its implication for gas and aerosol sample transport. The CFD results of flow features in the inlet are compared against high-speed wind-tunnel experiment results of average internal flow velocities, turbulence intensities, and gas transport losses. These comparisons provide critical validation of the reliability of turbulent models and support further validation of different designs. We will present the results of CFD simulations and wind-tunnel validation tests, and discuss implications for aircraft based gas-aerosol sampling.

10IM.2

Low-Cost Characterization of Wildfire Emissions Using a Novel Sensor Array. AMANDA GAO, Matthew Goss, Erik Helstrom, Jesse Kroll, *MIT*

Wildfires, which emit a host of harmful airborne pollutants, are becoming larger and more frequent in the United States. Biomass burning is a major source of atmospheric volatile organic compounds (VOCs), which are directly harmful to human health and produce secondary pollutants such as PM2.5. Real-time indoor measurements of VOCs and aerosols emitted from wildfires are generally made using state-of-the-art mass spectrometers that can be challenging to use due to their high cost and substantial maintenance requirements. Here, we describe low-cost measurements of wildfire emissions made using optical particle sensors and a novel VOC sensor array. The novel sensor array design seeks to overcome the limitations of any single VOC sensor, which can only output a single broadband scalar value representing varying sensitivities toward a wide range of compounds; here, we leverage multidimensional data made from twelve non-specific VOC sensors representing three fundamentally different measurement technologies, each with unique, controlled parameters. By using low-cost measurements of indoor wildfire smoke intrusion and ambient wildfire smoke emissions alongside data from co-located reference instruments, we examine the extent to which the response of the sensor array provides useful and quantitative information about wildfire smoke composition and chemistry. This work also provides an improved understanding of low-cost sensor capabilities and limitations in measuring wildfire emissions and helps to inform future developments and applications.

10IM.3

Effects of Lens Geometry and Nozzle Dimensions on Aerodynamic Focusing. Harrison Griffin, Mustafa Hadj Nacer, Salix Bair, Bjoern Bingham, W. Patrick Arnott, Judith Chow, John Watson, XIAOLIANG WANG, *University of Nevada, Reno*

Straight-edge thin plate orifices (90° half angle) are used as the focusing elements in most aerodynamic lenses. They are simple to fabricate and have fewer boundary layer effects as compared to other geometries such as capillaries, converging nozzles, and diverging nozzles. The focusing performance of these other geometries has not been systematically evaluated. This study used computational fluid dynamics (CFD) simulations and Lagrangian particle tracking to investigate aerodynamic focusing of converging and diverging orifices with half angles ranging from 30° to 150° at two Reynolds numbers (50 and 100) and three Mach numbers (0.03, 0.1, and 0.3). The results show that the optimal Stokes number (St_o) for near-axis particles have small differences between the straight-edge orifice and the converging or diverging orifices, indicating small changes in focusing behavior for different lens geometries. This study also investigated the effects of the dimensions of the exit nozzle on particle terminal trajectories in the vacuum chamber. The nozzle has a cylindrical constriction upstream of the exit orifice. Several nozzle radial aspect ratios and lengths of the constriction were simulated in a two-dimensional axisymmetric domain for a range of flow conditions. The nozzle geometry that generates the least divergent particle beam in the vacuum chamber is identified.

10IM.4

Aerosol Sampling from Aircraft: Impact of Turbulence on Aspiration and Transmission Efficiencies. NAGARAJAN RADHAKRISHNAN, Sreekesh Kookkal, Suresh Dhaniyala, *Clarkson university*

Computational fluid dynamics (CFD) studies of particle transport in aircraft sampling systems have typically overlooked the influence of turbulence on particle trajectories. This is largely due to the error in discrete random walk (DRW) models that are built-in CFD software such as ANSYS Fluent, that result in overprediction of particle loss due to turbulence. In this study, we use a newly developed DRW model to evaluate the role of turbulence in two aircraft inlet designs – a classical solid wall inlet with an expansion region downstream of the entrance and a porous inlet with boundary layer suction. The CFD simulations are conducted with two Reynolds Averaged Navier Stokes (RANS) models: k-ε and k-ω SST in 2D and 3D. The solid wall inlet is modeled under sampling flowrates ranging from isokinetic to anisokinetic. The porous wall inlet is modeled with isokinetic sampling and varying amounts of boundary layer suction. The inlet aspiration and transmission efficiencies were calculated for both inlets using FLUENT's in-built DRW model and the newly developed DRW code. In this presentation, we will highlight the role of turbulence on sampling performance considering both the CFD models, both DRW models, and the two inlet designs. The results will be compared against classical results obtained ignoring turbulence.

Keywords: Aircraft sampling, Turbulent deposition, Boundary layer suction, Low turbulence inlet.

10IM.5

The BioCascade-David: An Integrated Cascade Impactor for Inhalation Toxicology and Bioaerosol Collection. SRIPRIYA NANNU SHANKAR, Yuetong Zhang, Yuqiao Chen, Eric Le, William Vass, John Lednicky, Tracey Logan, Rebeccah Messcher, Gregory S. Lewis, Arantzazu Eiguren-Fernandez, Stavros Amanatidis, Tara Sabo-Attwood, Chang-Yu Wu, *University of Florida*

Particle size is one of the main factors governing the transport, deposition, and fate of particles in the atmosphere as well as in the respiratory system. Existing aerosol collection and exposure systems are capable of either depositing size-fractionated particles onto a dry surface or exposing cells maintained in liquid medium to all airborne particles without size-fractionation. While the former leads to loss of particles during extraction or loss in viability of bioaerosols collected, the latter does not provide information on size-dependent properties. The BioCascade paired with the Dosimetric Aerosol *in Vitro* Inhalation Device (DAVID) collects airborne particles into liquid in 4 stages (>8.5, 3.9-8.5, 1.3-3.9 and <1.3 µm) when operated at 4.5 L/min. The performance of the BioCascade-DAVID when challenged with aerosols generated during combustion was demonstrated using smoke particles from burning incense. Samples collected in stage 3 (1.3-3.9 µm) contained the highest concentration of redox compounds (48±7 µg/mL) and antioxidant potential (4.0±1 µM ascorbic acid equivalents), as assessed by Dithiothreitol and ascorbic acid assays respectively. *In vitro* anti-inflammatory activity, evaluated by inhibition of bovine serum albumin denaturation assay, showed compounds present in stage 2 inhibited the protein denaturation by ~27%, followed by stage 3 (~22%). From the samples collected in liquid medium using the BioCascade-DAVID, 32 and 71 organic compounds were detected by Gas Chromatography and Liquid Chromatography, respectively. The BioCascade-DAVID was further evaluated for collecting and delivering viable Human Coronavirus-OC43 to Vero E6 cells, as exemplified by the initiation of virus-induced cytopathic effects 3 days post inoculation, in stages 3 and 4. The results demonstrate the applicability of the BioCascade-DAVID in collecting size-fractionated aerosols and delivering them to a liquid medium for ease of analyses or to deliver particles directly to cells, without compromising the viability of the virus or host cells.

10IM.6

Volatility Distribution of Organic Aerosols using ChemSpot Instrument. PURUSHOTTAM KUMAR, James Hurley, Braden Stump, Athena Xu, Nathan Kreisberg, Nga Lee Ng, Pat Keady, Susanne Hering, Gabriel Isaacman-VanWertz, *Virginia Tech*

A larger portion (>50%) of atmospheric particulate matter consists of organic aerosols but due to their complex and diverse chemical composition their properties and impacts remain poorly understood. The volatility distribution of these organic aerosols provides information on their chemical composition and transformation pathways in the atmosphere, which is crucial for understanding their sources, transport, and impacts on air quality and climate. Traditional techniques for the volatility-resolved composition of organic aerosol involve measurement using a thermal denuder in conjunction with high-resolution mass spectrometry or a filter-based approach connected to a mass spectrometer. Although these techniques provide detailed valuable volatility-resolved organic aerosol composition data, they are still limited by their complexity and cost. Here we present volatility distributions and chemical composition of organic aerosol using the newly developed "ChemSpot" instrument, in which collected particles are thermally desorbed from an inert surface in controlled steps for chemical analysis using a flame ionization detector coupled with a CO_2 monitor and sulfur detector. Samples were collected under ambient conditions in Blacksburg, VA, and during laboratory biomass burning experiments of forest floor material during the Georgia Wildland-fire Simulation Experiment (G-WISE). We examine here the volatility distributions and oxygen content (i.e., 2D volatility basis) in fresh and aged particles, and compare these results to data from collocated particle mass spectrometers.

10SA.1

An Improved Understanding of Ambient VOC Sources in New York City Metropolitan Area. LUCILLE JOANNA BORLAZA-LACOSTE, Md. Aynul Bari, Sarah Lu, Philip K. Hopke, *University at Albany, SUNY*

Due to changes in energy and environmental policies and energy markets in New York State over the last two decades, there has been interest in understanding the effect of these changes in emissions from different energy sources (e.g., power, transportation, and residential sectors) on air quality in New York City (NYC) metropolitan area. NYC metro area with its more than 23 million residents is an EPA nonattainment region for O_3 and likely is a VOC-limited region. It has a complex coastal topography and meteorology with low-level jets and sea/bay/land breeze circulation associated with heat waves, leading to summertime O_3 exceedances and formation of secondary organic aerosol (SOA). To date, no comprehensive source apportionment studies have been done to understand the contribution of local and potential long-range VOC sources in the NYC metro area. This study will address these gaps by applying an improved dispersion-normalized Positive Matrix Factorization (DN-PMF) model for source apportionment of VOCs in the NYC metro area. The study will use 24-hr VOC canister measurements collected from four urban sites (NY: Queens, Bronx, Kings, NJ: Elizabeth), one suburban site (Richmond) in NYC and one background site in New Jersey (Chester) for the period 2000–2021. The study will also investigate long-term trends in source contributions to O_3 and SOA formation over the study period 2000–2021 by coupling DN-PMF and piecewise trend analysis. The changes in source contributions for three periods of major changes in Federal and State actions regarding energy use and resultant emissions: before (2005–2007), during (2008–2013), and after (2014–2021) will be also examined. Findings will assist the regulatory agencies in developing appropriate policy and management initiatives to control O_3 pollution in NYC metro area.

10SA.2

Improved Source Apportionment of Black Carbon-Containing Particles in a Complex Tropical Urban Environment: Insight from a Soot Particle Aerosol Mass Spectrometer. Mutian Ma, Laura-Helena Rivellini, ALEX K.Y. LEE, *Environment and Climate Change Canada*

Positive matrix factorization (PMF) analysis of aerosol mass spectrometry measurements has been extensively used for source apportionment of ambient organic aerosol (OA), but the interpretation of specific OA sources remains challenging. Due to the unique capability of a soot particle aerosol mass spectrometer (SP-AMS) that can detect black carbon (BC), OA, metals and inorganic aerosol (IA) simultaneously, this work utilizes all these chemical information in the PMF analysis in order to advance our understanding on emission and atmospheric aging of BC-containing particles in Singapore, a highly complex urban environment under the influence of various local and regional anthropogenic emissions.

The PMF analysis of BC and OA coating can identify two primary OA (POA) with large differences in BC content that were dominated by local traffic-related emissions, and two secondary OA (SOA) impacted by local chemistry and/or regional transport. By including metal signals in the PMF analysis, an industrial-influenced OA factor that was strongly associated with Na, V, and Ni can be separated from local traffic emissions. In addition, two biomass burning-influenced OA (BBOA) factors with different degree of oxygenation were clearly identified. While K and Rb were largely associated with the two BBOA-related factors, the more oxidized/aged BBOA component accounted for over 95% of potassium sulfate signals that were likely produced via heterogeneous aging during regional transport. Lastly, the integration of IA into the PMF analysis can further provide insight into how SOA formation might be associated with inorganic nitrate and sulfate formation chemistry.

10SA.3

Detection, Spatial Analysis and Source Apportionment of Polycyclic Aromatic Hydrocarbons using a Mobile Aerosol Mass Spectrometer.

OLADAYO OLADEJI, Albert A. Presto, Sunhye Kim, *Carnegie Mellon University*

Polycyclic Aromatic Hydrocarbon (PAH) are semi volatile organic compounds, generated from the incomplete combustion of organic compounds, that can be harmful to human health. They are a part of air toxics that can cause serious health effects even at extremely low levels.

There has been limited information on the spatial distributions of PAHs in cities in part because of a lack of real-time, chemically specific methods. The Aerosol Mass Spectrometer (AMS) is well suited for mobile sampling that can generate citywide concentration maps. The AMS is also sensitive to some PAHs, several of which are detected at the parent ion mass-to-charge ratio.

This study seeks to identify, quantify, spatially analyze, and provide a source apportionment of particle-phase PAHs using mobile AMS sampling. Sampling was done in Pittsburgh. A mobile laboratory was driven over defined routes in areas of varying source activity (e.g., the downtown core, residential areas, and industrial areas).

We quantified concentrations of Acenaphthene, Acenaphthylene, Naphthalene alongside other PAHs, as well as oxy-PAHs with the AMS. The concentrations of most reduced PAHs were both spatially and temporally variable. For instance, the mean concentration of Acenaphthene varied by a factor of 3 between neighborhoods. Most of the detected PAHs had low background concentrations and the time series of concentration was dominated by short intense concentration spikes.

PAH concentration spikes were correlated with black carbon (BC), suggesting vehicle emissions as a major source. Ratio-ratio plots (e.g., PAH/BC) suggest that most of the observed spikes can be attributed to emissions from nearby gasoline and diesel vehicles, with diesel vehicles being the dominant source.

10SA.4

Real-time Detection of Condensed Polycyclic Aromatic Hydrocarbons (PAH) on a Molecular Composition Level at Low pg/m³ Levels by CHARON FUSION PTR-TOF 10k.

MARKUS MUELLER, Markus Leiminger, Andreas Klinger, Tobias Reinecke, *IONICON Analytik GmbH., Innsbruck, Austria*

Condensed polycyclic aromatic hydrocarbons (PAHs) are highly toxic organic compounds formed naturally through incomplete combustion of organic materials but also through various anthropogenic processes. Even at lowest exposure levels, such as 1 ng m^{-3} of the commonly found benzo(a)pyren, PAHs can be detrimental to human health. However, detecting these compounds can be challenging due to their semi-volatile nature and low proton affinity. Proton transfer reaction mass spectrometry (PTR-MS), a soft chemical ionization technique, is able to detect condensed PAHs at low concentrations on a molecular composition level in the gas and condensed phase.

Herein we present a new generation PTR-TOF instrument that combines a clean Fast-SRI ion source, a radio-frequency ion molecule reactor (“FUSION”) and a high resolution TOF-MS (mass resolution >10k). This FUSION PTR-TOF 10k instrument reaches unprecedented sensitivities up to 80,000 cps ppbV^{-1} and limits of detection (LOD) < 1 pptV in 1 s. The original setup was successfully modified to reduce sample flow and now allows for coupling of a CHARON particle inlet including an aerodynamic lens system. Consequently, LODs are further improved by a factor 20 for particles in the size range of 100-1000 nm. This high time resolution CHARON FUSION PTR-TOF 10k allows for the real-time detection of condensed PAHs on a molecular composition level, well below harmful exposure levels with 1-min LODs down to low pg m^{-3} levels.
To demonstrate the outstanding capabilities of this new instrument, we present a first characterization of ambient organic aerosol in Innsbruck, Austria. From this dataset, a series of PAHs is identified and time-series of lowest mass concentrations are determined. We found 1-min LODs for $C_{16}H_{10}$ (i.e. pyrene, fluoranthene) and $C_{20}H_{12}$ (e.g., benzo-pyrene, benzo-fluoranthene) of 70 and 25 pg m^{-3}, respectively. Subsequently, matrix factorization is applied, delivering insight into separate sources of PAHs.

10SA.5

New Markers and Monitoring Concepts for Ship Emissions Using Single-Particle Mass Spectrometry. Johannes Passig, Julian Schade, Ellen-Iva Rosewig, Lukas Anders, Robert Irsig, Seongho Jeong, Thorsten Streibel, Thomas Adam, Hendryk Czech, Andreas Walte, RALF ZIMMERMANN, *University of Rostock*

Air pollution from ships affects the atmospheric environment with substantial impacts on public health and climate. Up to 400,000 annual deaths were attributed to ship emissions (Sofiev et al., 2018). Emission control areas (ECA) are widespread to protect coastal regions by limiting the ship fuel's sulfur content. In ECAs, the traditional bunker fuels are either replaced by distillates such as marine gasoil (MGO) or the ships are equipped with exhaust cleaning devices ("scrubber") to reduce the sulphur emissions. While the cleaner fuels also produce severe health effects, they do not contain metal residues from the refinery process. Thus, the traditional marker concept for ship emissions becomes obsolete because it is based on these metals. We target this gap by introducing a new method to detect ship emission particles by their content of polycyclic aromatic hydrocarbons. Using new ionization methods in SPMS (Schade et al., 2019), we measured single-particle PAH mass spectra from a ship engine running on different fuels and found fuel-specific signatures for the majority of particles (Anders et al., 2023). These PAH fingerprints are highly stable for different engine loads and particle sizes and indicate the used fuels independent from the metals. Beyond the PAHs, we could also substantially improve the SPMS sensitivity to the metals in bunker fuel emissions by exploiting resonance effects during ionization (Passig et al., 2020). This enhances the range of plume detection to more than 10 kilometres and allows to detect particles even from ships with scrubbers installed (Passig et al., 2021). We also present results from chasing ship plumes at open sea and show that compliance checks for the allowed fuels can work over distances of several kilometers with our technique (Rosewig et al., 2023).

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10SA.6

Rapid Summertime Transformation of Biomass Burning and Other Emissions to Highly Aged Toxic Background Organic Aerosol. CHRISTINA N. VASILAKOPOULOU, Angeliki Matrali, Ksakousti Skylakou, Evangelia Siouti, Maria Georgopoulou, Kalliopi Florou, David Patoulias, Andreas Aktypis, Christos Kaltsonoudis, Athanasios Nenes, Spyros N. Pandis, *University of Patras, Greece*

Wildfires are a significant source of biomass burning organic aerosol (bbOA) during summer, with major environmental impacts on air quality and global climate. Measurements were conducted in a remote continental eastern Mediterranean forest site during summer 2022, to study the bbOA produced from European wildfires. An Aerosol Mass Spectrometer (AMS) was used for the measurements of the particle phase. Other on-line instrumentation included a PTR-MS, SP2, aethalometer, SMPS, OPS, and gas-monitors. Samples were collected for the measurement of additional ions, metals, oxidative potential (OP) and ^{14}C. The average OA was 7.4 μg m^{-3}, a high level for a remote area.

The PM$_{2.5}$ fire emissions for that month in Europe were estimated to be 25,000 tn d^{-1}. However, the AMS Positive Matrix Factorization (PMF) results did not indicate any fresh bbOA. Three highly oxygenated secondary factors were identified: biogenic OOA (bOOA) (23% of the total OA), a less-oxidized OA (LO-OOA) (37%) and a more-oxidized OA (MO-OOA) (40%). Using potassium measurements and typical biomass emission composition data for Europe, we estimated that bbOA should be of the order of 5 μg m^{-3}. Analysis of the evolution of selected major fires in the Balkans suggests that the corresponding bbOA is converted in 1-2 days mostly to MO-OOA. High OP values were observed for the whole period (average DDT$_v$ equal to 0.34 nmol min^{-1} m^{-3}) and the days influenced more by fires (higher potassium levels) had the highest DDT$_v$. Chemical transport modeling with PMCAMx suggested that fires from Portugal affected this remote site in Greece thousands of kilometers away. The aged biomass burning OA contributes significantly to the background OA over Europe during the summer and due to its toxicity is estimated to have significant health effects on citizens of most European countries living far from the actual fires.

11AC.1

Atmospheric Nucleation Potential of Complex Mixtures. COTY JEN, Jack Johnson, *Carnegie Mellon University*

Atmospheric aerosol particles can impact Earth's radiation balance and act as the seed for cloud droplet formation. Over half of all the cloud seed particles are formed through nucleation, which is when gas-phase compounds react to form particles. Reactions of sulfuric acid with a wide variety of atmospheric compounds have been previously shown to drive nucleation in the lower troposphere. However, global climate models poorly predict particle nucleation rates since current nucleation models are currently unable to describe particle nucleation rates of complex nucleation reactions. The nucleation potential model (NPM) was recently developed to model sulfuric acid nucleation of complex mixtures of compounds. This work further applies the NPM to show that the model can accurately capture both enhancement and suppression effects of atmospherically relevant compounds such as methanesulfonic acid. NPM is also shown to capture sulfuric acid nucleation rates with a complex mixture of organic and inorganic acids, ambient air, and across a range of atmospherically relevant relative humidities. NPM provides a simple and effective way to estimate how various compounds in a complex mixture enhance sulfuric acid nucleation rates using a condensation particle counter.

11AC.2

Detection of Sulfuric Acid - Dimethyl Amine Nucleation Process using Ambient Pressure Proton Transfer Reaction Mass Spectrometry (AP-PTRMS). JUN ZHENG, *Nanjing University of Information Science and Technology*

Globally, nucleation processes contribute about half of the aerosol number concentration in the atmosphere. The sulfuric acid – dimethyl amine (SA-DMA) nucleation system is found to be the dominating nucleation mechanism in relatively polluted environments both theoretically and empirically. Based on observations using the nitrate-CIMS, the critical step of a nucleation process was believed to be the formation of a SA-dimer, which can be stabilized by a DMA, leading to enhanced nucleation rates. However, thermodynamic calculations demonstrated that $SA_n{\cdot}DMA_m$ clusters, where n = m, were the most stable clusters, and the formation of a SA·DMA was proposed to be the critical step during the SA-DMA nucleation process, although $SA_n{\cdot}DMA_m$ clusters have not been directly observed during field measurements. These discrepancies between observations and theories were likely due to the working principle of a nitrate-CIMS. When SA and its clusters were detected by a nitrate-CIMS, a nitrate anion (NO_3^-) takes a proton from a SA molecule or attaches to the SA-containing clusters. This can decrease the acidity of SA clusters, which may alter their original composition by losing a ligand (e.g., water, ammonia, and/or DMA). Here, we developed a new technique, AP-PTRMS, to detect the major clusters formed by a SA-DMA nucleation system. Water clusters of hydronium ions ($H_3O^+{\cdot}(H_2O)_{n=1,2,3\ldots}$) were used as the primary reactant ions and DMA was then protonated by $H_3O^+{\cdot}(H_2O)_n$ to form $DMA{\cdot}H^+$, which can readily attach to a $SA_n{\cdot}DMA_m$ cluster to complete the ionization process. Using a flow-tube reactor and in-situ generated SA gas, the most abundant $SA_n{\cdot}DMA_m$ clusters detected were SA·DMA followed by $SA_2{\cdot}DMA_2$ and $SA_3{\cdot}DMA_3$. These results were further verified by a kinetic model simulation based on $SA_n{\cdot}DMA_m$ condensation/evaporation rates. This new CIMS technique can be used to better reveal the true ambient nucleation processes and may also be used to measure the ambient SA concentration.

11AC.3

Biogenic New Particle Formation in the Presence of SO2 and Ammonia. VIGNESH VASUDEVAN GEETHA, Lee Tiszenkel, Shanhu Lee, *The University of Alabama in Huntsville*

New particle formation (NPF) is the major source of cloud condensation nuclei. Whereas NPF has been frequently observed in boreal forests with abundant monoterpenes, NPF occurs very rarely in deciduous forests with dominant emissions of isoprene. Typically, laboratory studies of biogenic NPF have been conducted mostly from oxidation reactions of monoterpene (and some isoprene), while many forests are also affected by transported plumes containing SO_2 (and hence sulfuric acid). Also, ammonia is ubiquitous in the atmosphere and abundant in forests. Still, laboratory studies of multicomponent biogenic NPF are very scarce. We have conducted NPF experiments in the Tandem Aerosol Nucleation and Growth Environment Tube (TANGENT) from α-pinene and isoprene oxidized with ozone in the presence of SO_2 and ammonia. Particle size distributions in the size range from 1-100 nm are measured with PSM (Particle Size Magnifier) and SMPS (scanning mobility particle sizer). Sulfuric acid and ammonia are measured in real-time with two CIMSs (chemical ionization mass spectrometers). The chemical composition of HOMs (highly oxygenated organic molecules) is measured online with HrTOF-CIMS (high-resolution time of flight chemical ionization mass spectrometer), and offline with LC-ESI (liquid chromatography-electrospray ionization) high-resolution Orbitrap mass spectrometer. In this talk, we will discuss how SO_2 and ammonia affect the biogenic aerosol nucleation rate and growth rate and the chemical composition of HOMs in the gas and particle phase. These results will help to better understand the biogenic NPF processes under conditions that mimic the mixed deciduous forests in the United States.

11AC.4

Chemical and Meteorological Controls on New Particle Formation in the Southern Great Plains. BRI DOBSON, Harald Stark, Daniel Katz, Jordan Krechmer, Chongai Kuang, Manjula Canagaratna, Douglas Worsnop, Eleanor Browne, *University of Colorado Boulder & CIRES*

New particle formation (NPF) is estimated to account for 40 – 70 % of cloud condensation nuclei and therefore plays a central role in our understanding of aerosol-cloud interactions. It is well established that the likelihood of NPF is influenced by both chemical precursors, such as sulfuric acid, ammonia, amines, and organic compounds, as well as physical atmospheric conditions. However, the complexity of the process leads to large uncertainties in the representation of NPF in models. A complete understanding of the conditions that lead to NPF requires observations of both gas-phase composition as well as physical and meteorological conditions. Additionally, these measurements must be made in diverse ecosystems as both chemical and physical conditions vary by region.

We investigated NPF in an agricultural region, a land-use category that has been understudied compared to urban and forested regions. We deployed an atmospheric-pressure interface time-of-flight mass spectrometer (APi-TOF) and a chemical ionization time-of-flight mass spectrometer with ethanol reagent ion (EtOH-CIMS) to the US Department of Energy Atmospheric Radiation Measurement (ARM) Southern Great Plains (SGP) site in rural Oklahoma in October 2021 and April/May 2022. Using these mass spectrometry measurements of gas-phase compounds along with the long-term meteorological measurements from the ARM SGP site we investigate the chemical and physical conditions that contribute to NPF. I will discuss select NPF and growth events, which were identified using the nano scanning mobility particle sizer at the SGP site. Analysis focuses on the role of amines and ammonia in NPF. Additionally, differences in HYSPLIT back trajectories between event days suggest different gaseous precursors may be transported to the site and available to participate in nucleation and growth on different days. These factors, along with varying atmospheric conditions cause differences in new particle formation and growth over the course of a few days at the same location.

11AC.5

Chemical Identification of New Particle Formation and Growth Precursors through Positive Matrix Factorization of Ambient Ion Measurements. DANIEL KATZ, Aroob Abdelhamid, Harald Stark, Manjula Canagaratna, Douglas Worsnop, Eleanor Browne, *University of Colorado Boulder & CIRES*

Ambient gas-phase molecular ions and ion–molecule clusters determine atmospheric electrical properties and promote new particle formation (NPF). In the lower troposphere, positive and negative charges are respectively transferred to the most basic and most acidic species. Measurements of ambient ions and clusters are therefore highly selective towards poorly characterized species thought to be important for NPF and growth. Because NPF affects the atmospheric radiation budget and hydrologic cycle, understanding the global impacts of NPF requires better insight into the chemical precursors of NPF in diverse regions. Agricultural regions represent a major land use category, but a lack of trace gas measurements in such regions impedes understanding of how crop emissions contribute to secondary aerosol. We measured ambient ion composition using an atmospheric pressure interface time-of-flight mass spectrometer (APi-ToF) during one month of the 2016 Holistic Interactions of Shallow Clouds, Aerosols, and Land Ecosystems campaign in the agricultural Southern Great Plains region. We use binned positive matrix factorization (binPMF) and generalized Kendrick analysis (GKA) to constrain chemical formulas of observed ions and reveal their temporal variation without the need for long-timescale averaging or a priori high-resolution peak fitting. Clusters charged by NO_3^- and HSO_4^- core anions dominate negative ion mode observations. Both anions cluster with sulfuric acid, nitric acid, and organic compounds including organosulfates. Highly oxygenated organic molecules (HOMs) derived from monoterpene (MT) and sesquiterpene (SQT) oxidation are observed as NO_3^- clusters. Organonitrates derived from NO_3 radical oxidation of SQTs account for most of the HOM signal and, along with other SQT oxidation products, likely contribute to particle growth at the site. We suggest that SQTs represent an underappreciated source of secondary organic aerosol in agricultural regions. We show that binPMF analysis of APi-ToF measurements provides insight into the temporal evolution of compounds important for NPF and growth.

11AE.1

Use of Real-Time Aerosol Monitors to Evaluate Secondhand Electronic Cigarette Aerosol Exposure Inside Vehicles. SINAN SOUSAN, Ronald Mooring, Sarah Fresquez, Yoo Min Park, Vivien Coombs, Nicole Bertges, Luke Thomas, Emily Gold, Anish Gogineni, Alex Tiet, Jack Pender, Eric Soule, *Department of Public Health, East Carolina University*

Electronic cigarette (ECIG) use continues to be highly prevalent, especially among youth and young adults. Secondhand ECIG exposure puts bystanders at risk of inhaling harmful substances, especially in confined spaces. A study was conducted to measure secondhand ECIG aerosol exposure inside vehicles, with participants completing a 30-minute vaping session in their own vehicle using their preferred ECIG device. Sessions included a 5-minute 10-puff directed bout (30 second interpuff interval) followed by a 25-minute ad libitum bout. Real-time and filter $PM_{2.5}$ (particles 2.5 µm and smaller) measurements were captured during the sessions using a MiniWRAS, pDR, SidePak, and GeoAir2 low-cost monitor. A total of 56 participants with valid measurements were included in the study, with a total of 13 different ECIG brands, that include Vuse Alto, Box Air Bar, ElfBar, Esco Bar, Geek Vape, Hyde Edge, JUUL, Kang Onee Stick (KOS), Kang Onee Stick plus (KOS+), Nord X, Nord 2, Nord 3, and Vaporesso. During the 5-minute directed bout, the highest real-time PM2.5 average concentrations were represented by the JUUL (176 µg/m^3) measured by the MiniWRAS, Esco Bar (1,154 µg/m^3) measured by the pDR, and the Esco Bar (3,314 µg/m^3) measured by the SidePak, where the pDR and SidePak values were much higher than the MiniWRAS. The filter measurements were not detectable for most experiments, except for two participants who took 205 and 285 puffs, ~10 times the average (30) puffs of all participants. The evaluation of GeoAir2 with the MiniWRAS showed a wide range of r values that spanned from -0.03 and 1.00 for the 13 ECIG brands. The mass median diameter (0.31 to 3.42 µm) and geometric standard deviation (2.47 to 8.21) were different based on the participants for the same ECIG brand. Secondhand ECIG aerosol exposure inside vehicles could be hazardous, especially for high concentrations during short periods.

11AE.2

Inhalation Doses of Back Carbon at the US-Mexico Port of Entry San Ysidro/El Chaparral. Rita Zurita, Penelope Quintana, Yanis Toledano-Magaña, Fernando Wakida, LUPITA D. MONTOYA, Javier Castillo, *Universidad Autónoma de Baja California, México*

The San Ysidro/El Chaparral Port of Entry (SYPOE) is the most active port in the Western hemisphere. Previous studies have associated high concentrations of ultrafine particles, carbon monoxide (CO), and black carbon (BC) with waiting times during border crossing. BC has been air quality indicator for evaluating the health risks of air quality dominated by primary combustion particles The objective of this study was determined the inhalation dose of BC of pedestrian border crossers and workers at the SYPOE. BC sampling took place between November 2017 and January 2019. The inhalation dose of BC was calculated according to published methods. The highest average daily dose for pedestrians was estimated for autumn 2018 (5.9 µg) corresponding to a 60min waiting time. For the workers, an average daily dose was also estimated based on their individual working schedule, and the highest was in winter 2017 (19 µg for an average of a 10-hr work shift). Diurnal distribution of inhalation dose of BC for workers at the SYPOE showed the highest doses between 7:00 to 9:00 am and 7:00 to 9:00 pm. Decreasing waiting times for pedestrians on days with high air pollution would reduce their inhalation doses. More importantly, limiting doses of workers may require modifying their schedule to decrease their exposure. These recommendations would partially address environmental justice in the border area.

11AE.3

Mobile Metal Aerosol Measurement in Industrially Adjacent Neighborhoods. EDWARD FORTNER, Mina Tehrani, Benjamin Werden, Megan Claflin, Conner Daube, Tara Yacovitch, Joseph Roscioli, Scott Herndon, Brian Lerner, Peter F. DeCarlo, *Aerodyne Research, Inc.*

This study investigates the concentration of metal aerosols in neighborhoods adjacent to industry in the Baton Rouge to New Orleans corridor in February 2023. The Aerodyne Mobile Laboratory (AML) and on-board suite of gas and particle instruments allows for mobile sampling of air quality. Measurements of aerosols chemical speciation and sizing are accomplished by an Aerodyne Soot Particle Aerosol Mass Spectrometer (SP-AMS). The SP-AMS combines conventional Aerodyne aerosol mass spectrometer (AMS) measurements of real-time, size-resolved composition of nonrefractory, aerosol particle ensembles with the ability to measure refractory particles. Nonrefractory aerosol particles are thermally vaporized at 600°C while refractory particles are vaporized by a 1064 nm laser. The resulting vapor is ionized and the ions are detected in a high-resolution mass spectrometer. Laser vaporization allows for the direct detection of metal species present in aerosols.

In this work, we compare mobile metal measurements from the SP-AMS to results from a Cooper Environmental Xact 625i ambient metals monitor also installed in the AML. The XACT 625i uses X-ray fluorescence on collected particles to accurately quantify a number of metals and was run in fast-sampling mode with five- minute resolution. The SP-AMS collected data at 1 second resolution providing superior spatial and temporal resolution but is limited in quantification and is therefore complementary to the XACT 625i. The SP-AMS and Cooper XACT625i sampled a wide variety of different metals as this campaign investigated air toxic metals in communities adjacent to industrial and metal processing facilities. We detected elevated levels of many metals including chromium, cadmium, mercury and lead during this campaign in these mixed industrial/residential areas.

This study highlights potential health risks associated with exposure to metal aerosol pollution in these neighborhoods and the need to develop effective strategies for reducing exposure in these areas.

11AE.4

PAH Concentration in Size Resolved Aerosol Emissions during Firefighting Activity. SHRUTI CHOUDHARY, Darlington Imhanzuaria, Umer Bakali, Chitvan Killawala, Natasha Solle, Erin Kobetz, Alberto Caban-Martinez, Pratim Biswas, *University of Miami*

The incidence of certain cancers is higher among firefighters than the general population they serve. The international agency for research on Cancer reclassified occupational exposure as a firefighter as carcinogenic to humans (Group 1) in June 2022. PAH and PFAS are one of the major classes of carcinogenic chemicals that may increase the risk of developing different types of cancer due to occupational exposure. Multiple studies have documented increased extraction of PAH in urine and breath samples following firefighting due to possible exposure via dermal and inhalation routes even when firefighters use personal protective equipment. Firefighters can be exposed to high concentrations of toxic aerosols during fire training, however little is known about the aerosol composition that could lead to increased levels of PAH and PFAS in firefighters after inhalation. In this study, we use an eight-stage Anderson impactor to collect size-resolved aerosol followed by PAH and PFAS characterization through mass spectrometry and liquid chromatography coupled with mass spectrometry respectively. We then compare the identified PFAS and PAH compounds with the associated biomarkers reported in the literature to estimate the possible respiratory exposure and determine the possible pathway for the exposure.

11AE.5

Optimization of a DIY Air Cleaner Design to Reduce Residential Air Pollution Exposure for a Community Experiencing Environmental Injustices. Nicholas Clements, SUMIT SANKHYAN, Allison Heckman, Jonathan Aumann, Shelly L. Miller, *University of Colorado Boulder*

$PM_{2.5}$ exposure has been linked to several adverse health effects including cardiovascular system related comorbidities that could lead to increased mortality rates among the general population. These health burden risks are disproportionately higher for populations living in low-income neighborhoods primarily because most of these living spaces lie near major traffic centers and industrial areas, which are significant sources of $PM_{2.5}$ and volatile organic compounds (VOCs). These pollutants often infiltrate indoors leading to unhealthy indoor air quality in many of the homes in these neighborhoods.

Large scale deployment of “do it yourself” (DIY) air cleaners made from HEPA filters attached to a box fan could be an effective intervention method for addressing exposure disparities by reducing $PM_{2.5}$ and VOC levels indoors where people spend most of their time on daily basis. However, there have been very few studies that reported feedback from the occupants regarding long-term usage in their homes. In this study we evaluated six different types of DIY air cleaner prototypes to select the ideal design for large scale deployment (~50 homes) in low-income neighborhoods around the Denver metropolitan area. We found out that the protypes with single filters fared much better than ones containing multiple filters in terms of clean air delivery rates normalized by annual running costs, ease of build, and overall size. The survey results regarding the DIY air cleaner usage demonstrate that in addition to noise, continuous operation of these DIY air cleaners was also hindered by cold air flow affecting thermal comfort of the residents and reluctance by the participants to use these protypes in front of outside company fearing embarrassment over its basic and inelegant design.

11CM.1

Optimizing Personal Exposure to Particulate Matter, Energy Consumption and Thermal Comfort Inside a Test House.

NISHCHAYA MISHRA, Marina Vance, Atila Novoselac, Sameer Patel, *Indian Institute of Technology Gandhinagar*

People worldwide spend more than 80% of their time in the built environment, and thus it becomes imperative to assess indoor environment quality (IEQ), which affects human health, comfort, and productivity. IEQ is primarily controlled by indoor air quality (IAQ) and heating, ventilation, and air conditioning (HVAC) systems. The HVAC operation in buildings accounts for a significant fraction of global energy consumption. A healthy and comfortable indoor environment is energy intensive owing to the interdependency of IAQ, thermal comfort, and energy consumption. This leads to a trade-off between occupants' health, thermal comfort, and building energy consumption.

The work presented here employs a dynamic optimization strategy for controlling indoor particulate matter (PM), thermal comfort, and energy consumption. Following three different scenarios for normal and intensive PM emission in an indoor environment are discussed in this work - (1) without an HVAC filter, (2) with an HVAC filter, and (3) extreme ambient conditions. An aerosol dynamic model integrated with a physics-based model of HVAC operation was developed. PM measurements from cooking activities performed during the HOMEChem study conducted in a test house were used as input for the aerosol dynamics model. The HVAC system was modeled to maintain the house's thermal comfort and air recirculation. Further, an objective function was defined to optimize the model and penalize the exceedance of thresholds for IAP concentration and indoor temperature. The dynamic optimization minimizes an objective function constituting energy consumption, exposure, and thermal comfort. Parametric and sensitivity analysis were performed to quantify the tradeoff between the three components of the objective function. Results provide novel insight into the complex interdependence between personal exposure, building operation, and comfort.

11CM.2

Long-term Experience with Rapid Air Filtration (6 to 15 Air Changes Per Hour) in a K-5 Elementary School Using HEPA and Do-It-Yourself (DIY) Air Purifiers during the COVID-19 Pandemic. DEVABHAKTUNI SRIKRISHNA, *Patient Knowhow, Inc.*

EPA recommends DIY air cleaners for temporary use during wildfires, and a recent EPA study presented at AAAR reported their inconsistent usage in homes due to excessive noise. Questions also remain about wear and tear including how long filters retain their filtration properties and need to be replaced. Herein we report real-world experience from daily usage of 47 HEPA and 60 DIY air cleaners in a California elementary school during the academic school year from spring 2021 through fall of 2022 across 16 classrooms, a library, an auditorium, a lunchroom, and in a hallway. Three to six purifiers were needed in classrooms to meet California (CDPH) recommended 6 to 12 air changes per hour (ACH) for prevention of aerosol transmission of COVID-19 in classrooms. Teachers reported noise generated by DIY purifiers on lowest fan speed as acceptable for classroom use. Filtration efficiency at 0.3 µm (most penetrating particle size) for DIY air cleaners with 5" MERV 16 filters used in the classrooms averages 77% after six months compared to 92% for newly installed filters. Portable air cleaners (HEPA and DIY) averaged and estimated 10 ACH (6-15 ACH) across the 16 classrooms demonstrating feasibility and unit economics of meeting CDPH targets per classroom for $200-$650 with DIY versus $600-$12,000 with the HEPA models used. In one 9000 cubic foot classroom with 7 air purifiers, air exchange rate was measured using ambient aerosols at 18 ACH from air purifiers (within 20% of ACH estimated based on CADR of purifiers) and 7 ACH from HVAC for a combined total of 25 ACH. The procedure using ambient aerosols to verify ACH from portable air cleaners and HVAC can be the basis for ACH certification or verification without generating aerosol contaminants (e.g. salt water, smoke, tracers) which may be unsafe or disallowed in schools.

11CM.3

Development of a New Laboratory Test Methodology for Rapid Ageing of HVAC Filters with a Representative Urban Aerosol Mass Size Distribution at High Concentration.

CHUNXU HUANG, Iane Gomes, Laura Ajala, Elliot Cram, Ta-Kuan Chuang, Nusrat Jung, Brandon E. Boor, *Purdue University*

Air filters installed in residential and commercial HVAC systems encounter a complex mixture of aerosols of outdoor and indoor origin during their service life. Standardized laboratory test methodologies are important for evaluating the loading behavior of HVAC filters. Loading aerosols commonly used to age HVAC filters include various test dusts (ISO-12103-1-A2, ISO-12103-1-A4, ASHRAE Test Dust) that are primarily composed of coarse mode particles (1 to 100 µm). However, urban aerosol mass size distributions often feature a prominent accumulation mode between 0.1 and 1 µm that is not well represented by traditional loading aerosols. The aim of this study is to develop a new laboratory test methodology for rapid ageing of HVAC filters with a representative urban aerosol mass size distribution at a high concentration to better predict long-term changes in HVAC filter performance. A HVAC filter test rig was custom designed and built following ASHRAE 52.2 specifications to artificially age HVAC filters with sub-micron potassium chloride (KCl) aerosol produced by a thermal aerosol generator. The KCl aerosol is formed by burning KCl sticks in a high temperature oxygen-propane flame and is delivered to the test rig via a damper-controlled intake duct. The loading behavior of a collection of air filters of variable design and efficiency (pleated MERV8, electrostatic bag MERV13, V-cell MERV14) was evaluated using the new experimental protocol. KCl aerosol size distributions were measured across the test filter using a scanning mobility particle sizer (SMPS) and a high-resolution electrical low pressure impactor (HR-ELPI+). Artificial ageing experiments were conducted until the filter pressure drop reached 1.5 in. H_2O. The new test methodology successfully aged MERV8, MERV13, and MERV14 filters to 1.5 in. H_2O in several hours. Loading curves were sensitive to the MERV rating, volumetric airflow rate, relative humidity, and KCl stick feed rate. The results demonstrate that the new sub-micron KCl loading aerosol is a time- and cost-effective technique to artificially age HVAC filters with a particle mass size distribution representative of that found in HVAC installations in buildings.

11CM.4

Experimental and Theoretical Studies on Characterisation and Capture of Single-Wire Square Crossectional Electrostatic Precipitator in Indoor Environment.

AISWARYA KUMAR, Prashant Nawale, Y. S. Mayya, Manoranjan Sahu, *Indian Institute of Technology Bombay*

Most individuals spend the majority of their working and living hours indoors. As particulate matter (PM) is found to be a health concern, several indoor PM control technologies are available on the market as well as at lab scales, but they have different drawbacks. Electrostatic precipitators (ESP), which are a preferred technology in industries, can achieve similar performance indoors with additional benefits like high removal efficiency even at lower PM concentrations, flexibility of keeping them as standalone/induct, ability to handle high velocity, lesser energy consumption, recovery of being washed, multiple pollutant removal and low maintenance. Compared to other ESP geometries that were well studied in literature as well as considered in different theoretical contributions, single-wire square cross-section geometry has multiple advantages like easier adaptation for design as well as a multiplication for various applications, space-filling characteristics, corona, as well as collection efficiency could be modelled at same time as charging as well as collection happens simultaneously and as approach to modelling is relatively straight forward. As there is a requirement to customise ESP for a particular application, single-wire square cross-section ESP was designed, operated and tested for its performance experimentally. As experimental investigation can be complicated under some circumstances, a model was developed to predict PM capture efficiency theoretically with automatic consideration of the effects of space charge and theory of corona. Results from experimental settings were compared with the developed model in terms of characterization, which is the behaviour of the corona discharge as well as PM capture efficiency of ESP. Good agreement was found between theoretical and experimental data with a corona breakdown voltage of 7.75 kV. Similarly, PM capture efficiency in clean and worst indoor scenarios was found to be following the same trend in theoretical as well as experimental studies, with a total efficiency value above 95% for PM size range of 10 nm to 5 µm. Although not that significant, model underestimated efficiency compared to experimental values, which could be due to non-ideal scenarios in experiment setting or due to the assumptions to which area and other radial parameters were approximated. As results from the study seem promising in terms of PM capture efficiency as well as with secondary effects of air cleaning systems such as by-product emission, energy consumption, and multipollutant removal, there is a possibility of scaling up to various applications like air purifiers and outdoor air cleaning.

11CM.5

PEGI: Peroxide Enhanced Germicidal Irradiation for Rapid Bioaerosol Disinfection. EMMALEE BIESIADA, Mark Hernandez, *University of Colorado at Boulder*

Conventional aerosol disinfection systems rely either on chemical disinfectants or ultraviolet irradiation (UVGI) to inactivate airborne microorganisms. Here we present here, the engineered combination of trace hydrogen peroxide vapors with low-doses of ultraviolet light to achieve the accelerated disinfection of viral and bacterial bioaerosols. The purposeful activation of hydrogen peroxide with germicidal UV is introduced as PEGI: Peroxide Enhanced Ultraviolet Disinfection. Below its NIOSH personal exposure limit (1 ppm) vaporized hydrogen peroxide (H_2O_2) was activated using different doses of conventional and far UV light. Using separate UVGI sources (222 nm and 254 nm), we present the PEGI disinfection response of bioaerosols commonly use model the disinfection response of airborne bacteria and viruses. In both pilot ($1m^3$) and full-scale chambers ($10m^3$), the inactivation of airborne Bacillus subtilis, its spores and MS2 virus was observed at higher (60% RH) and lower (25% RH) humidity level, in the presence and absence of UV irradiation and peroxide vapor alone, and in combinations. Under all conditions tested, the inactivation rates associated with PEGI exposures were significantly greater than with either UV or H_2O_2 exposures alone, under otherwise identical conditions. These results suggest that PEGI induces a synergist biological inactivation response in the atmospheric environment at low and mid-range relative humidity. Under PEGI exposure, peroxide activation with 222 nm light enabled a more potent airborne disinfection scenario than its 254 nm counterpart, when normalized by the spherical irradiance (UV dose) received by the respective bioaerosols in the presence of trace amounts of hydrogen peroxide vapor. While the purposeful application of UV and hydrogen peroxide has been leveraged in aquatic environments for advanced oxidation of potable water, this approach has not been used for aerosol disinfection. Results from this study demonstrate PEGI feasibility and provide basic design parameters for the rapid inactivation of bioaerosols in contained environments.

11ID.1

Secondary Organic Aerosol Production from a 222 nm Germicidal Lamp. MATTHEW GOSS, Victoria Barber, Lesly Franco Deloya, Lexy LeMar, Yaowei Li, Erik Helstrom, Manjula Canagaratna, Frank Keutsch, Jesse Kroll, *MIT*

The Covid-19 pandemic has accelerated the need to reduce the levels of airborne pathogens within indoor spaces. One novel mitigation strategy, the use of KrCl excimer lamps (222 nm) for ultraviolet disinfection, has recently gained attention since it effectively inactivates pathogens while posing little risk via direct skin and eye exposure. However, the effect of 222 nm light on indoor air chemistry is poorly constrained. Here we carry out a set of experiments in which VOCs are added to a 150 L environmental chamber and exposed to 222 nm light. Gas-phase species are monitored using an ozone monitor, Vocus (H_3O^+-CIMS), and PTR3 (NH_4^+-CIMS), and particle-phase products are measured using an aerosol mass spectrometer and scanning mobility particle sizer. We find that 222 nm lamps can produce substantial levels of ozone and OH; when VOCs are present, these oxidants react to form oxidized VOCs and secondary organic aerosol (SOA). This work examines the amount and composition of the SOA formed from 222 nm photooxidation of three VOCs (hexanal, cyclohexene, and limonene). Results are extrapolated to realistic indoor conditions, enabling estimates of SOA concentrations in indoor environments as a function of ventilation and 222 nm light intensity.

11ID.2

Health Impacts of GUV222-Generated Pollution under Low Ventilation May Be Its Most Important Limitation. JOSE-LUIS JIMENEZ, Joost de Gouw, Daven Henze, Zhe Peng, *University of Colorado, Boulder*

Germicidal ultraviolet disinfection at 254nm (GUV254) has been used for a century, with its perceived main limitation being careful installation to avoid skin/eye irradiation. GUV222 has received intense recent attention, due to much reduced skin/eye impacts. However, both wavelengths produce indoor air pollution, which had not been examined in detail.

Although it has been known that some O_3 is generated by GUV222, its importance is ~10,000 higher than previously thought. This is a combination of (a) an O_3 generation rate ~100 times larger than in a recent review (Claus, 2021) and (b) the incorrect assumptions that only O_3 itself was a concern; that any O_3 lost indoors is of no consequence; and that any remaining O_3 below threshold limit values of 50-100 ppb has negligible health impacts; (c) the fact that O_3 and radicals generated from it (OH, NO_3) combine with very abundant indoor volatile organic compounds (VOCs) to produce indoor PM, a pollutant ~50 times more deadly than O_3 itself on a mass basis. Additional risks due to oxidized VOCs, ultrafine particles, and possibly unknown unknowns remain to be characterized.

Application to a simple case study shows that GUV222 at the ACGIH limit under low ventilation may result in as many deaths from indoor pollution as the lives saved from reducing infection. Very low fluence rates may still have significant germicidal properties (if viral disinfection results from Welch et al. 2021 hold in the real world), and may allow the use of GUV222 even under low ventilation. GUV254 results in less pollution formation under low ventilation. Ventilation reduces GUV222 pollution quadratically, as O_3, VOC, and PM are all diluted. Filtration reduces PM, while activated carbon can reduce O_3 and VOC. Health benefits vs. harms of GUV222 are explored vs. average fluence rate and ventilation / filtration rates.

11ID.3

Far-UVC Generated Ozone Levels in a Hotel and Comparison to Outdoor Concentrations. PETRI KALLIOMÄKI, Phillip Stratton, Kristen K. Coleman, Aditya Kiran Srikakulapu, Ross Salawitch, Russell R. Dickerson, Shengwei Zhu, Jelena Srebric, Donald K. Milton, *University of Maryland*

Far-UVC (222 nm UV light) is a promising tool to mitigate aerosol transmission of infections indoors. However, concerns related to ozone production and secondary chemistry (like formation of secondary organic aerosols) have been raised. Data related to indoor ozone concentrations in real-world settings are also lacking.

In this study, we measured ozone concentrations and fine particles (17-500 nm) with and without 222 nm far-UVC in a regular guest room and in a well-sealed test room in a hotel in downtown Baltimore (MD) between February 16th and March 10th (2023). The baseline ventilation rate was 0.3 air changes per hour (ACH) in the well-sealed room and 1.3 ACH in the regular room. The UV power intensity was 4.6 mW/m^3 in the well-sealed room and 5.5 mW/m^3 in the regular room. Indoor ozone concentrations were compared to outdoor concentrations (EPA Ambient Air Monitoring Network) around the Baltimore area.

In the well-sealed room, the average ozone concentration was 2 ppb when the UV lights were off and 13 ppb when on, compared to average outdoor concentrations of 22 ppb and 23 ppb, respectively. The average ozone concentration in the regular room was 10 ppb when UV was off and 12 ppb when UV was on, compared to average outdoor concentrations of 35 ppb and 27 ppb, respectively. Particle measurements did not show a clear signal related to UV usage.

Although indoor ozone levels increased during far-UVC usage, the concentrations remained lower than outdoors. The effect of infiltration on indoor ozone concentrations can also be significant, especially if buildings are not well sealed. Nonetheless, more information related to factors governing ozone concentrations and secondary chemistry (e.g. secondary organic aerosols) in buildings is needed.

11ID.4

The Efficacy of Grignard Pure(TM) to Inactivate an Airborne SARS-CoV-2 Surrogate. Grishma Desai, Gurumurthy Ramachandran, Emanuel Goldman, William Esposito, Antony Galione, Altaf Lal, Toni Choueri, Andre Fay, William Jordan, Donald Schaffner, Jack Caravanos, Etienne Grignard, GEDIMINAS MAINELIS, *Rutgers, The State University of New Jersey*

The COVID-19 pandemic spurred a renewed interest and search for safe and effective means to inactivate airborne pathogens, including viruses. Limited research conducted during the 1940s and 50s suggested that triethylene glycol (TEG) could be used against airborne pathogens. TEG is considered a “Safer Chemical” by the EPA; it has been used for many years for theatrical special effects, and also in air fresheners. Grignard Pure^{TM} (GP) was developed with TEG as the active ingredient, and it also contains water and other ingredients to aid in faster evaporation while preventing fire hazards. Since the active ingredient in GP is TEG, it follows that GP would have antimicrobial properties in the air. This study characterized the efficacy of GP for inactivating MS2 bacteriophage – a nonenveloped virus widely used as a surrogate for SARS-CoV-2. Experiments conducted in two independent laboratories measured the decrease in airborne viable MS2 concentration in the presence of different concentrations of GP from 15 to 90 minutes while accounting for both natural die-off and settling of MS2. Two different experimental protocols were used: GP aerosol was introduced into the air containing MS2, and airborne MS2 was introduced into the air containing GP aerosol. Overall, we found that GP consistently and rapidly reduced viable MS2 bacteriophage concentration by 2-3 logs at GP concentrations of 0.04 mg/m^3 to 0.5 mg/m^3 (corresponding to TEG concentrations of 0.025 mg/m^3 to 0.287 mg/m^3). GP efficacy experiments by other researchers will also be discussed and compared with our findings. We conclude that GP is indeed an effective antiviral air treatment that could be used to limit indoor airborne transmission of SARS-CoV-2 and other airborne viral pathogens.

11ID.5

Do-It-Yourself Air Cleaners as an Emergency Measure to Reduce Indoor Exposure to Respiratory Aerosols. WILLIAM LINDSLEY, Raymond Derk, Jayme Coyle, Francoise Blachere, Stephen Martin, Jr., Kenneth R. Mead, Donald Beezhold, John Noti, *National Institute for Occupational Safety and Health*

Portable air cleaners can be used to reduce indoor exposure to infectious airborne pathogens, wildfire smoke, allergens, and other hazardous aerosols. However, during a public health emergency such as the recent COVID-19 pandemic, the need for air cleaners can greatly exceed the available supply and financial resources. Consequently, a variety of do-it-yourself (DIY) air cleaner designs have been developed and widely disseminated. We tested two DIY air cleaner designs in a simulated classroom with a breathing simulator acting as a source of respiratory aerosols and three breathing simulators acting as recipients exposed to these aerosols. Optical particle spectrometers monitored the concentrations of the simulated respiratory aerosol particles (0.3–3 µm) in the breathing zones of the recipient simulators and throughout the room as the particles dispersed. Our results showed that using the DIY air cleaners in various configurations provided an additional 0.4 to 6.6 effective air changes/hour (ACH) per unit above the 2 ACH baseline provided by the room HVAC system. Using two DIY air cleaners and the HVAC system reduced the average aerosol exposures by a range of 41% to 78% compared with using the HVAC system alone. Increasing the number of filters per DIY unit, the filter thickness, and the fan airflow significantly increased the effective air change rate and exposure reductions. Our results show that DIY air cleaners can be an effective means of reducing indoor aerosol exposures. However, they also show that the performance of DIY air cleaners can vary considerably depending upon their design, construction, and positioning, and thus that the lack of quality control testing for DIY air cleaners presents an important limitation to their use. Simple methods to test and monitor the performance of DIY air cleaners need to be developed to ensure that the air cleaners perform as expected.

11NM.1

Molecular Dynamics Simulations of Nanoscale Heat Transfer in the Free Molecular Regime. TIMOTHY SIPKENS, *National Research Council Canada*

Nanoscale conduction is a fundamental quantity relevant to some laser diagnostics for particles, energy storage by aerosols (e.g., iron–iron oxide nanoparticles), and gas sensors, among other applications. For small particles that make up many aerosols, conduction takes place in the free molecular (or transition, where modeling still requires knowledge of the free molecular) regime. Free molecular conduction between the particles and the surrounding gas is then quantified by the thermal accommodation coefficient (TAC), which marks the effectiveness of individual collisions between gas molecules and the particle surface. Molecular dynamics (MD) is a theoretical approach for examining these individual molecular collisions and computing the heat transfer across an ensemble of these collisions. This study uses the molecular dynamics method first introduced by Daun et al. (2009), which repeatedly scatters individual gas molecules, sampled from an equilibrium gas, from a small volume of surface material. This study examines the effect of interatomic potential on MD-derived TAC for a range of materials and phases. We also present TACs for new surfaces, such as metal oxides and amorphous carbon, with the objective of expanding our understanding of trends in the TAC for realistic surfaces.

11NM.2

Influence of Oxidizing and Reducing Process Gases on Metallic Aerosol Nanoparticles. VINZENT OLSZOK, Philipp Rembe, Alfred P. Weber, *Clausthal University of Technology*

Metallic nanoparticles consisting of one or more components exhibit unique properties that make them highly suitable for application in catalysis, electronics, and medicine, to name only a few possible fields. With a particular focus on electronic properties such as band gap or electron work function, the affinity for oxidation is a critical aspect when dealing with nanoscaled metal. A simple method to produce metallic nanoparticles is given by spark ablation. Single element or multi-component particles are feasible to synthesize using two metallic electrodes and a continuously flowing process gas. This contribution aims at highlighting the importance of controlling residual oxygen in the chosen process gas. Even a so-called "inert gas" such as nitrogen 7.0 (99.99999%) has been found to enable oxide formation during nanoparticle production. The addition of hydrogen to a process gas seems to be a simple intervention in order to suppress oxide formation. This contribution also shows, on the one hand, that hydrogen is able to adsorb on metallic NP even at room temperature. On the other hand, hydrogen has been found to alter the morphology of openly structured agglomerates made of platinum, which is susceptible to hydrogen adsorption. A self-developed analytical tool (Aerosol Photoemission Spectroscopy, APES) that is able to detect oxidation and adsorption phenomena in an online process will be presented. In addition, a patented gas-cleaning tool will be demonstrated that is able to produce ultra-clean (uc) nitrogen with a corresponding purity of 99.9999999999999999% and exhibit a residual oxygen level equivalent to that in interplanetary space. Using uc N2, metallic and oxide-free aerosol nanoparticles can be produced without the use of hydrogen. By means of electron work function determination by APES, the capability of the gas-cleaning unit will be discussed, as will the interaction of hydrogen and residual oxygen in inert gases with metallic aerosol particles.

11NM.3

High-Resolution Differential Mobility Analysis (HR-DMA) of sub-10nm Nanoparticles Synthesized by the Reactive Spray Deposition Technology.

FARNAZ KHOSRAVI, Evangelos K. Stefanidis, Zhiqiao Zeng, Stoyan Bliznakov, Leonard J. Bonville, Radenka Maric, Francesco Carbone, *University of Connecticut*

The Reactive Spray Deposition Technology (RSDT) is a technique that enables the deposition of flame-synthesized nanoparticles with sizes smaller than 10nm on proton conductive membranes to fabricate Membrane Electrode Assemblies (MEAs). The Size Distribution Function (SDF) of the synthesized nanoparticles can affect the performance of the manufactured electrodes. Therefore, in this study, we apply High-Resolution Differential Mobility Analysis (HR-DMA) to measure the SDFs of the platinum (Pt) nanoparticles synthesized by two RSDT turbulent jet non-premixed flames. A thin-walled tubular probe equipped with a micron-sized orifice is used to sample and quickly dilute the RSDT flame products at different distances from the fuel nozzle, L. The samples are diluted in pure nitrogen flowing in the tube and transferred to a Half-Mini HR-DMA to implement their size classification before counting by a Faraday Cup Electrometer. The measurements are repeated using a sampling orifice diameter of both 0.25mm and 0.15mm to assess the effect of dilution on the coagulation and charge redistribution dynamics occurring in the sampling system. Measurements performed in equivalent flames deprived of the platinum precursor enable the distinction between platinum nanoparticles and small hydrocarbon chem-ions. Results are consistent with recent literature data reporting the nanoparticle SDFs at L=150mm as obtained by deposition and microscopy analysis and the average nanoparticle diameter across the flame length as measured by in-situ laser diagnostics. The HR-DMA results demonstrate that the platinum nanoparticles have bimodal SDF, with the first mode located at around 1nm, and the second mode exhibiting a lognormal distribution with a constant relative width. The center of the second mode shifts from 4.6nm to 6.4nm at increasing distances from the fuel nozzle (L), from 150mm to 300mm, as the nanoparticles coagulate and age within the flame.

11NM.4

Aerosol Detonation Synthesis of Core-Shell TiO2-Graphene-TiC Hybrid Photocatalysts.

Ahmed Al Mayyahi, Shusil Sigdel, Placidus Amama, CHRISTOPHER M. SORENSEN, *Kansas State University*

We have developed a chamber detonation process for large-scale synthesis of high-quality TiO2-graphene-TiC hybrid catalysts from liquid precursors. The method builds directly on our novel aerosol detonation synthesis method to create multi-layer graphene.The liquid precursors, toluene and titanium tetrachloride, are placed in a 17L chamber which is filled with oxygen. The chamber is heated to evaporate the liquids. Then the gaseous mixture is ignited with an electric spark. The resulting exothermic reaction yields an aerosol of multi-layer, turbostratic graphene-TiO2-TiC and graphene-TiO2 composites with atomic ratios that can be tuned by adjusting the ratios of the precursors. This tunable composition in turn allows tuning of the optical and catalytic properties of the product. The product demonstrates strong photocatalytic behavior with visible light by both lowering the band gap of TiO2 and having the nanographene act as reservoir to retard the recombination of electron-hole pairs. Advantages are associated with the chamber detonation process are: minimal energy needs, short synthesis time, environmentally benign, economic viability, scalability and tunable product selectivity.

11NM.5

Process Design for Carbon Black Size and Morphology.

GEORGIOS A. KELESIDIS, Simon Benz, Sotiris Pratsinis, *Rutgers, The State University of New Jersey*

The structure (size and morphology) of carbon black (CB) largely determines its performance in tires, inks, batteries etc. (doi.org/10.1016/j.cej.2021.129884). Here, the impact of CB process synthesis variables, i.e. temperature, T, precursor (i.e. acetylene) flow rate, Q, and volume fraction, φ, on CB structure (size and morphology) is elucidated by discrete element modeling (DEM; doi.org/10.1016/j.carbon. 2017.06.004) and compared to experimental data in the literature. The CB structure is quantified by the mobility, d_m, and primary particle, d_p, diameters, effective density, ρ_{eff}, and fractal dimension, D_f. Decreasing Q or T enhances the CB yield, surface growth and agglomeration. This increases the mean dm and dp, consistent with experimental data from laminar flow ethylene pyrolysis reactors. The CB made at high Q or T is less compact than that made at low Q and T, having up to 50% smaller peff and 30% smaller D_f, in excellent agreement with experimental data also. Increasing the φ (e.g. by increasing the precursor flow rate), results in CB aggregates (covalently-bonded CB spherules) and increases the mean d_m and d_p, explaining commercial furnace black data. These CB aggregates are quite compact having up to 45% larger D_f and larger peff than those of ethylene black. So process design diagrams generated by the present DEM simulations can be used to guide design and optimization of CB for various applications (e.g. batteries, doi.org/10.1016/j.carbon.2022.06.020) from first principles.

11RA.1

Examining the Vertical Heterogeneity of Aerosols over the Southern Great Plains.

YANG WANG, Chanakya Bagya Ramesh, Scott Giangrande, Jerome Fast, Xianda Gong, Jiaoshi Zhang, Alyssa Matthews, Fan Mei, John Shilling, Jason Tomlinson, Dié Wang, Jian Wang, *University of Miami*

Both aerosol direct and indirect effects on climate are affected by the vertical distribution of aerosols in the atmosphere, which is influenced by a range of processes, such as aerosol dynamics, long-range transport, and entrainment. However, many observations of these processes are based on ground measurements, limiting our ability to understand the vertical distribution of aerosols and simulate their impact on clouds and climate. In this work, we examined the vertical heterogeneity of aerosols over the Atmospheric Radiation Measurement (ARM) Southern Great Plains (SGP) using data collected from the Holistic Interactions of Shallow Clouds, Aerosols and Land Ecosystems (HI-SCALE) campaign. Based on the 38 flight measurements during HI-SCALE, the aerosol properties over the SGP show strong vertical heterogeneity and seasonal variabilities. The aerosol concentrations at the surface are the highest due to strong sources of emission at ground level. The mode diameter of these aerosols during summer (~ 100 nm) is larger than that during spring (~ 30 nm), potentially as a result of enhanced condensational growth due to enriched volatile organic compounds in summer. In the BL, the size of the aerosols gradually increases with altitude due to condensational growth and cloud processing. Through the vertical profiles of aerosol properties, we noticed a considerable number of NPF events (7 out of 38) in the upper BL, where the newly formed particles continue to grow as they are mixed down to the surface. There is also an indication that deep convection brings aerosols from the free troposphere (FT) to the surface, where they grow to contribute to the cloud condensation nuclei (CCN). Overall, the vertical heterogeneity of aerosols over the SGP is influenced by aerosol dynamics (new particle formation, growth, and cloud processing) and transport processes (long-range transport, entrainment, and convective downward transport).

11RA.2

Humidity-Induced Changes in the Optical Properties of Dust Particles. KYLE GORKOWSKI, Rachael Dal Porto, Christopher Cappa, Ryan Farley, Qi Zhang, Abu Sayeed Md Shawon, Jordan Spencer, James E. Lee, Katherine Benedict, Manvendra Dubey, Allison Aiken, *Los Alamos National Laboratory*

Dust is a ubiquitous atmospheric particle that has significant impacts on climate, air quality, and human health. While the optical properties of dust, such as absorption coefficients, have been studied extensively, the influence of humidity on these properties is poorly measured despite dust particles often encountering varying levels of atmospheric moisture.

In this study, we report on new field measurements taken in Houston during the DOE ARM's TRACER-CAT campaign in July 2022. We investigated the effects of humidity on the optical properties of dust using a combination of field measurements and numerical simulations. We used a custom-built instrument, the dual-channel Humidified-Cavity-Attenuated Phase Shift-Single Scattering Albedo Particulate Matter Monitor (H-CAPS-PM), to measure the optical properties of dust particles under controlled levels of relative humidity. Our results show an increase in aerosol scattering and extinction, as well as an increase in single scatter albedo, with increasing humidity. However, the absorption increase with humidity was found to be variable.

To assess our measurements, we also conducted simulations using the Mie theory with modified effective refractive indexes to include the effect of water uptake by dust particles. The simulations confirmed the changes in the optical properties of dust particles due to humidity and showed the importance of incorporating these effects into atmospheric models.

Our findings have important implications for understanding the role of dust in atmospheric processes and climate change. By incorporating the effects of humidity on dust optical properties into atmospheric models, we can improve our predictions of dust radiative forcing and the resulting impacts on regional and global climate.

11RA.3

Large Contribution of Shoreline Wave Breaking to Coastal Cloud Condensation Nuclei Population. SHENGQIAN ZHOU, Xianda Gong, Eduardo de Azevedo, Francisco Reis, Matthew Salter, Timothy Bertram, Jian Wang, *Washington University in St. Louis*

Sea spray aerosol (SSA) emission is one of the largest sources of global aerosol mass budget, but its contribution to cloud condensation nuclei (CCN) concentration is still under debate. For example, a recent study suggests that the SSA contribution to CCN concentration likely has been underestimated. Long-term measurements on islands or in coastal regions are often used to study SSA. The wave breaking near the shoreline, which is distinct from the open-ocean processes, may generate a large flux of SSA. However, the impact of such flux on the observed aerosol properties, especially the concentration and hygroscopicity of fine particles, has rarely been investigated. Here we show enhanced aerosol number and CCN concentrations with abnormally strong fluctuations under the conditions of high waves and onshore wind. The enhanced concentrations and strong fluctuations are due to SSA emission by incoming waves lapping the shoreline and/or swell wave breaking in the surf zone. While wind speed is the key parameter determining the SSA flux in open oceans, we found that the SSA production at shoreline primarily depends on the wave height, and high wave often exists under the conditions of low wind speed. Strong SSA production by shoreline wave breaking occurs ubiquitously and frequently in both rocky and beach shorelines, making a substantial contribution to the CCN population in nearby downwind areas. Using one-year measurements on Graciosa Island in Eastern North Atlantic, we show almost all events when ambient fine aerosols exhibit sea-salt-like hygroscopicity can be explained by the shoreline SSA generation. Therefore, extrapolating the results based on coastal measurements to open oceans without taking into account the shoreline effects may significantly overestimate the contribution of SSA to CCN concentration, and by extension, the impact of SSA on clouds and climate.

11RA.4

Impacts of Sea Ice Leads on Sea Salt Aerosols in the Arctic: Results from Chemical Transport Modeling. ERIN EMME, Hannah Horowitz, *University of Illinois Urbana Champaign*

Tropospheric aerosols, such as sea salt aerosol, have the potential to alter Arctic climate through aerosol direct and indirect radiative effects. However, the exact sources and processes contributing to cold season sea salt aerosol in polar regions are still under debate, preventing the improvement of polar aerosol and climate models. While the open ocean is the major accepted source of sea salt aerosols, studies suggest that open leads in sea ice could play a dominant role. Climate change has impacted the Arctic by decreasing sea ice extent and sea ice thickness, which can increase the frequency of leads. Here, we combine satellite datasets and the 3-D atmospheric chemistry transport model GEOS-Chem to investigate the pan-Arctic emissions of sea salt aerosols from open leads. Sea salt aerosol emissions from leads are calculated in GEOS-Chem using the same parameterization as open ocean emissions, scaled by the areal fraction of open leads, using the Harmonized Emissions Component (HEMCO) at the native resolution of MERRA-2 (0.5°x0.625°). Daily lead area fraction is determined from AMSR-E satellite data, for the months of November to April in years 2002 to 2008. We perform two GEOS-Chem full chemistry simulations at the highest global resolution (2°x2.5°): one with sea salt aerosol emissions for the default, open ocean + blowing snow only emissions, and the default plus lead-based emissions. HEMCO ensures the emissions at the lower resolution needed for the full chemistry simulation are of consistent magnitude with the emissions calculated at the native MERRA-2 resolution. For both cases, we simulate sea salt aerosol concentrations which we evaluate against observations, and assess the impacts of additional SSA emissions on atmospheric chemistry. This includes analysis of the change in atmospheric concentrations of bromine atom (Br) and ozone.

11RA.5

Annual Variability of Particle Size, Cloud Condensation Nuclei, and Particle Hygroscopicity in the Central Arctic. Xianda Gong, Jiaoshi Zhang, Betty Croft, Xin Yang, Markus Frey, Rachel Chang, Jessie Creamean, Chongai Kuang, Randall Martin, Arthur J. Sedlacek, Janek Uin, Sascha Willmes, Maria Zawadowicz, Jeffrey R. Pierce, Matthew Shupe, Julia Schmale, JIAN WANG, *Washington University in St. Louis*

Temperatures in the Arctic are rising at more than twice the global average rate, and aerosol plays an important role in the Arctic climate. Currently, aerosol properties and sources remain poorly understood in the central Arctic, where observations are scarce. Here we present the seasonal variations of central Arctic aerosol properties observed during the Multidisciplinary Drifting Observatory for the Study of Arctic Climate (MOSAiC) campaign. Particle number size distribution exhibited high concentrations of accumulation mode (diameter > ~80 nm) during spring due to long-range transport pollution from lower latitudes and high concentrations of Aitken mode (diameter < ~80 nm) during summer as a result of more frequent new particle formation (NPF) events. CCN concentration (NCCN) during the springtime was often the highest (~110 cm-3 at a supersaturation of 0.30%). In comparison, NCCN during summer and fall was substantially lower (~ 20 cm-3) except when newly formed particles grew and reached a sufficiently large size (diameter > ~80 nm) to act as CCN. Particle hygroscopicity (expressed as a single parameter, κ) was low (~0.2 to 0.3) during summer and fall due to the strong contributions of organics to particle composition. During winter and spring, κ values ranged from ~0.5 to 1.2, indicating that sea salt particles generated from open leads/blowing snow contribute substantially to the aerosol population in the Arctic. Aerosol emissions, transport, and their effect on cloud properties need to be further studied to improve our understanding of Arctic climate change.

12AC.1

Modeled Impact of Deposition on the Oxidation Pathways of Common Reactive Precursors. CHENYANG BI, Gabriel Isaacman-VanWertz, *Virginia Tech*

Reactive organic precursors emitted into the atmosphere may undergo extremely-complex oxidation reactions, produce hundreds of thousands of oxidations products that have a wide range of functionality and reactivity, and significantly impact climate and human health. Consequently, methods to reduce such complexity are needed to interpret the large atmospheric dataset and identify key drivers in atmospheric processes. As one of the attempts to achieve this goal, we consider the fate of a compound in the atmosphere as competition between loss processes, particularly oxidation, which propagates chemistry and may form aerosol, and deposition, which removes reactive carbon from participating in further chemistry. Based on previous estimations of deposition and oxidation timescales of atmospheric reactive organics, we examine the competition between oxidation and deposition and understand the impacts of deposition on the downstream chemistry in the case of the oxidation of common precursors. Timescales for deposition are implemented as first-order processes into a box model to simulate the oxidation of single reactive precursors, such as isoprene and α-pinene, and a mixture of common reactive precursors found in the Southern Oxidant and Aerosol Study (SOAS) campaign. The simulations enabled the quantification of the fraction of oxidant reactivity and formation potential of secondary organic aerosol (SOA) that is removed or prevented by deposition. We prioritize the chemical products in a known cascade of complex oxidation reactions based on three key criteria: 1) compounds having competitive timescales, 2) compounds produced as early-generation products, and 3) compounds having high relative abundance. We demonstrate the importance of the three criteria by quantifying the impacts of those prioritized organics on the aerosol formation potential and total reactivity. We will also discuss the implications of this result for local and regional atmospheric composition.

12AC.2

Identifying and Quantifying Products Formed from the Reaction of Alkenoic Acids with OH Radicals in a Low NOx Environment. ANNA ZIOLA, Paul Ziemann, *University of Colorado Boulder*

Data from two Los Angeles field campaigns, CalNex in 2010 and LAAQS in 2020, show that the concentration of mid-day NO, a prominent component in VOC (volatile organic compound) oxidation mechanisms, has decreased by about 75%. While many studies have detailed how VOCs behave in high NOx environments and how these reactions contribute to aerosol formation, there is less information about these VOC mechanisms in the absence of or lower concentrations of NOx. To learn about this low NOx behavior and its contribution to aerosol formation, we reacted a 1-alkene with a terminal carboxylic acid, 3-butenoic acid and 5-hexenoic acid, with OH radicals while using an iodide chemical ionization mass spectrometer (I-CIMS) to identify the products. We used this carboxylic acid functional group tag because an I-CIMS is very sensitive to carboxylic acids, allowing us to easily detect both the reactant and the products. Once we identified the products, we synthesized standards of the resulting products to calibrate the I-CIMS and quantify them. This enabled us to determine mechanistic branching ratios and rate constants of the reaction. By comparing two systems with different carbon numbers and taking advantage of carboxylic acid properties, we were able to elucidate the mechanism and branching ratios of a 1-alkene and OH radical reaction in a low NOx environment and better understand its contribution to aerosol formation.

12AC.3

Rapid Photolysis Decay of Gaseous Organic Nitrates Formed from Hydroxyl and Nitrate Radical Oxidation of α-Pinene and β-Pinene. MASAYUKI TAKEUCHI, Yuchen Wang, Nga Lee Ng, *Georgia Institute of Technology*

Photolysis of gaseous organic nitrates plays an important role in the formation and fate of air pollutants, such as nitrogen oxides (NO_x) and ozone (O_3). Monoterpenes are prevalent biogenic volatile organic compounds, contributing to the formation of organic nitrates; however, there is currently a lack of experimental constraint on the photolysis chemistry of monoterpene nitrates. Here, we conducted laboratory chamber experiments to investigate photolysis of organic nitrates formed from hydroxyl and nitrate radical oxidations of α-pinene and β-pinene. We directly measured their photolysis rates by chemical ionization mass spectrometry (CIMS). The chamber photolysis rate constants vary depending not only on the molecular formulae of organic nitrates but also on the precursor type and oxidation condition. While the photolysis rate constants of many detected C10 organic nitrates are on the order of 10^{-5} s^{-1} or larger, the other C_{10} organic nitrates exhibit little to no decay behavior. The most photo-labile organic nitrate is $C_{10}H_{17}NO_5$ formed from nitrate radical oxidation of α-pinene and β-pinene with a chamber photolysis rate constant of 1.1 (± 0.1) and 1.3 (± 0.3) × 10^{-4} s^{-1}, respectively. We further determined that the ambient photolysis rate constant is as large as 6.4 (± 3.0) × 10^{-4} s^{-1} (corresponding photolysis lifetime of 0.43 ± 0.20 h). Compared to other loss processes (i.e., photooxidation and dry deposition) of gaseous organic nitrates, photolysis is a comparable or dominant loss process. These findings have important atmospheric implications regarding the role of monoterpene nitrates on the spatial distribution of NO_x and O_3 formation.

12AC.4

Measurements of Urban Secondary Organic Aerosol as a Function of Precursor Volatility Class in the Los Angeles Area during Summer 2022. MELISSA MORRIS, Benjamin Schulze, Andrew Jensen, Douglas A. Day, Pedro Campuzano-Jost, Anne Handschy, Melinda Schueneman, Seonsik Yun, Dongwook Kim, Donna Sueper, Harald Stark, Joost de Gouw, John Seinfeld, Paul Wennberg, Jose-Luis Jimenez, *University of Colorado, Boulder*

Urban secondary organic aerosol (SOA) significantly contributes to decreased air quality and poses human health risks, especially in metropolitan areas. Many research studies have been conducted in Los Angeles, contributing to our collective understanding of its complex atmospheric chemistry. However, one lingering question has prevented the development of stronger policies on SOA precursor emissions: what compounds are the major gas-phase precursors of SOA? Conflicting model results from the 2010 CalNex analyses were highlighted by policymakers, as there is disagreement on which gas-phase precursors are the most important: volatile organic compounds (VOCs) or semi- and intermediate-volatility compounds (S/IVOCs). To our knowledge, the constraints on this problem are very indirect (through models) and there are no direct experimental constraints.

This work presents measurements at Caltech in the summer of 2022, to address this question. Dual oxidation flow reactors (OFRs, which simulate 1-2 days of atmospheric aging in ~3 minutes) oxidized ambient air, and their outflow was sampled by an aerosol mass spectrometer, a Vocus 2R-proton-transfer-reaction time-of-flight mass spectrometer, and a scanning mobility particle sizer. Both OFRs ingested ambient air, but one was deployed without an inlet, while the other had an inlet made of electrically conductive polymer tubing. Previous work in our group has demonstrated how polymer tubing can be used to denude gas-phase compounds according to their volatility, covering the range of interest. Ambient and OFR results for the 2022 study are similar to those from CalNex 2010, including the amount and diurnal cycles of precursors, SOA, and SOA potential. We demonstrate how this approach can be used to separate ambient SOA as being due to precursors of different volatility classes. Preliminary results suggest that at least half of the SOA formed in the OFR is from compounds with volatilities in the SVOC and lower IVOC range.

12CM.1

Applying Real-Time On-Board Emissions Measurements and GIS Data to Evaluate the Applicability of AIS-based Emissions Inventory Estimates of Ocean-Going Vessels. RYAN W. DROVER, Thomas Eckel, J. Wayne Miller, David R. Cocker III, *University of California, Riverside*

Emissions of nitrogen oxides (NOx) from ocean-going vessels (OGVs) are a significant contributor to inventories in many cities, resulting in cities failing to meet clean air standards. Emissions from OGVs have been particularly challenging to account for, with emissions inventories developed off of time-intensive on-board sampling methods yielding emission factors which are applied based on reported vessel activity data (AIS). To reduce maritime NOx emissions, the International Maritime Organization (IMO) has implemented several effective actions.

This project measured the real-shipping emissions of NOx and particulate matter (PM) from two vessels meeting the latest standards and found the emissions met the Tier III standard within the Emission Controlled Area (ECA) and met Tier II standards after exiting the ECA, and one vessel developed under the prior Tier II standards. Real-time GIS data was recorded alongside the real-time NOx and PM measurements, and corroborated by the primary GPS units onboard the vessels. The primary finding in this research was at <25% power, the measured NOx emissions were seven times the Tier III standard. This finding is important as ships entering harbors or in go-slow zones operate at <25% power and are near people whose health should be protected. In this stage of the work, the complete vessel activity and real-time emissions were analyzed, identifying significant challenges in estimating emissions from OGVs based on traditional methods of EFs and AIS and supports contemporary calls for the adoption of continuous emissions monitoring systems for accurate emissions accounting.

12CM.2

Quantifying Ultrafine Particle Exposure and the Effectiveness of Mitigation Strategies for 3D Printers in Various Operating Environments. TIANYUAN LI, *University of Waterloo*

Over the past decade, 3D printers have gained popularity because of their ability to create intricate designs and affordability. However, their usage raises concerns about indoor air quality degradation. Many previous studies reported that operating 3D printers generates ultrafine particles (UFPs) that can cause adverse health effects, and their emission rates and composition can vary substantially depending on the machine model, printing temperature and filament type. This study uses Monte Carlo simulations to quantify the UFP concentrations with a wide range of emission rates reported in the literature for three scenarios: home offices, library printer rooms, and fabrication spaces. The effectiveness of mitigation measures, such as portable air cleaners with HEPA filters (PAC) and direct exhaust hoods, was also evaluated. The results show that a typical home office can reach a mean UFP concentration of 116,100/cm3 (std. dev. = 247,700) after just one hour of printing. Utilizing an appropriately-sized PAC recommended by AHAM can reduce the UFP concentration by 66%, although the resulting concentration is still four times the typical indoor level. The simulated concentrations are lower in library printer rooms (mean = 24,400/cm3, std. dev. = 42,000) and fabrication spaces (mean = 14,900/cm3, std. dev. = 22,000) because of the larger room volume and higher mechanical ventilation rates. The use of PAC in the printer room or exhaust hood in the fabrication space can further reduce the mean concentrations by 75.1% and 48.9%, respectively. However, higher ventilation and/or exhaust rates can also shift the origin of indoor UFPs from the 3D printers to outdoor sources (up to 97%), which is concerning for regions with elevated ambient UFP concentrations. This study demonstrates that 3D printers could substantially increase UFP exposure, suggesting that mitigation measures such as PACs, exhaust hoods, and potentially personal protective equipment should be considered to minimize the potential harm.

12CM.3

Separation of Aerosols by Localized Vapor Condensation.

PAOLO TRONVILLE, María José Rubio, Jesús Marval, Juan Vallejo, *Politecnico di Torino*

Many industrial processes generate vapors that must be removed from the exhaust fumes to obey maximum allowable emissions limits set by environmental protection agencies. Other processes, e.g., coffee roasting, release significant amounts of vapors that may have a commercial value into the atmosphere. These substances tend to condense in the exhaust systems, causing an economic loss due to the maintenance of the ducts and production stops. Hence, it is desirable to capture those vapors effectively, turning them into a resource whenever possible.

Examples of technologies suitable for removing vapors from the air are thermal oxidation, activated carbon adsorption, and wet scrubbers. However, those technologies require frequent maintenance and high operational costs.

We present experimental results measured on a prototype built to demonstrate the operation of new patented technology to remove vapors from the air. The idea is to force the vapor condensation into tiny droplets and separate them using a high-efficiency cyclone.

The fumes are cooled down and go through the device designed to separate the organic compound. After the inertial separation phase, part of the fumes is refrigerated and used to produce the condensation of the organic contaminant upstream of the inertial separator. At the same time, the remaining amount can be reintroduced into the oven. From the inertial separator, it is possible to collect the condensed contaminants. To obtain the desired result is crucial to identify the proper cooling temperature and airflow, optimizing the energy use to maximize the efficiency of this new technology.

The measured prototype’s collection efficiency was around 50%. The mass of the condensed contaminant depends on the cooling power available. We will refine the prototype further because the mass balance cannot be closed with available data. In future steps, the cooling section of the prototype can improve by introducing new heat exchange devices to promote the nucleation of the contaminants contained in the gaseous stream. Some solutions might include adopting a conduction heat exchange mechanism.

12CM.4

Application of Low-Cost Sensor Network for Real-Time Aerosol Monitoring in Medical Settings.

Kaitlyn Glenn, Jiayang He, James Hecker, IGOR NOVOSSELOV, *University of Washington*

We present the methodology to map the movement and size of particles using a network of low-cost particulate matter (PM) sensors to determine aerosol persistence in operating rooms (ORs) [1] and intensive care units (ICUs) [2]. Mimicking aerosol generation by a patient, we nebulized saline solution to create NaCl particles that function as tracers for potentially infectious aerosols. The ORs rapidly returned to the background after the aerosolization, with a minimum of 94 seconds and a maximum of 254 seconds due to the high air exchange rate. In ICUs, positive pressure (door closed) and neutral pressure (door open) ICUs took the longest to clear with a maximum of 830 seconds. Negative-pressure rooms returned to background level to background levels of aerosols on average 1.5-2 times faster than positive-pressure and neutral-pressure rooms (~500 sec). In positive and neutral-pressure rooms, the aerosol plume exfiltrates from the room ~1-2 minutes after the start of aerosolization, with up to 7% of total generated aerosols escaping the ICUs in positive-pressure rooms and up to 17% -- in neutral-pressure rooms. The outside sensors in negative-pressure ICUs remained at background levels in each experiment. After the initial spike at the aerosolization source (head of the bed), the rooms become 'well-mixed' after 100sec, i.e., the aerosol concentration becomes uniform. The PM level reduces the exponential decay rate. Negative pressure ICUs consistently had the fastest decay rate, with an average of 1.5-2 x faster than positive or neutral pressure rooms. Statistical K-means analysis of aerosol spatiotemporal distribution was performed; the clustering algorithm suggested that ICU could be divided into three distinct zones of similar aerosol levels. This gave similar results to zoning the room spatially by sorting the room into (i) the zone near the aerosolization source (the head of the bed), (ii) the periphery of the room, and (ii) the antechamber and directly outside the room. This research was limited by a small data set (5 ORs and 4 ICUs); additional work monitoring more ICUs and ORs would help validate this work and generalize the monitoring approach. This network monitoring approach can also be extended to other medical settings, such as emergency departments, ambulatory clinics, etc.

[1] J. G. Hecker et al., "Measuring aerosols in the operating theatre and beyond using a real-time sensor network," Anaesthesia, vol. 77, no. 10, pp. 1097-1105, 2022, doi: https://doi.org/10.1111/anae.15842.
[2] K. Glenn, J. He, R. Rochlin, S. Teng, J. G. Hecker, and I. Novosselov, "Assessment of aerosol persistence in ICUs via low-cost sensor network and zonal models," Scientific Reports, vol. 13, no. 1, p. 3992, 2023/03/10 2023, doi: 10.1038/s41598-023-30778-7.

12HS.1

History of Ambient Aerosol Sampling for Environmental Health Assessments. JOHN WATSON, Xiaoliang Wang, Judith Chow, *Desert Research Institute*

Although associations between suspended particulate matter (PM) and adverse effect on human health and ecosystems was known for hundreds of years, practical methods to quantify concentrations and exposures were lacking. Early attempts used passive methods, such as dustfall buckets and deposition plates followed by microscopic analyses, but it was eventually recognized that the larger and more massive particles that settled to the surface were not those that are inhalable and respirable. The availability of electrically-powered air pumps at the beginning of the 20th century permitted continuously pulling air through filters that could then be examined. This also permitted more precise measures of the air sample volumes. These filters were first analyzed for their degree of darkening as “British Smoke” to indicate soot concentrations. Active flow sampling was needed to determine radioactive exposures near the Nevada test site during above ground nuclear tests in the 1950s, and this evolved into the high-volume (hivol) sampler that was adapted to early air quality measurements of Total Suspended Particulate Matter (TSP). Hivols were applied in many urban areas and their mass concentrations were used in epidemiological studies that related TSP to adverse health indicators. This resulted in the first TSP National Ambient Air Quality Standards established by the U.S. EPA in the early 1970s. Further research indicated that smaller and more repeatable size fractions (PM10 and PM2.5) were better health indicators, and samplers were created with size-selective inlets that were less sensitive to meteorological conditions and sampling artifacts that affected the hivol. Recently developed aerosol samplers emphasize portability, smaller footprints, and ability to operate without electrical connections. Small, self-contained filter samplers have also evolved for personal and indoor monitoring.

12HS.2

A Review of Aerodynamic Lenses Development, Challenges, and Needs. XIAOLIANG WANG, Salix Bair, Harrison Griffin, Mustafa Hadj Nacer, Bjoern Bingham, W. Patrick Arnott, Judith Chow, John Watson, *Desert Research Institute*

Aerodynamic focusing lenses use a series of orifices (lenses) to generate a low-diverging particle beam, allowing particles to be efficiently delivered from ambient environments to a vacuum. They have been widely used as inlets for aerosol mass spectrometers. Most lenses used today are similar to the original design invented in early 1990s, with an effective focusing size range of approximately 30–600 nm. Several design extensions over the past several decades include: 1) nanoparticle lenses for focusing <30 nm particles; 2) “ambient” lenses for focusing particles up to 2.5 µm or even 10 µm to study $PM_{2.5}$, PM_{10}, or bioaerosols; 3) high flow rate lenses to increase particle throughput; and 4) ambient pressure lenses to extend to near ambient pressure applications. There are several fundamental and practical challenges in lens design and use. For example, the orifice jet flow is inherently unstable and increasing the flow rate leads to turbulence that destroys particle focusing. However, the critical Reynolds number that leads to laminar-to-turbulent transition is not well known. Novel focusing lens geometries to maintain laminar flow at higher Reynolds numbers have been proposed but have not been experimentally validated due to difficulties in manufacturing such lenses. Advances in 3D printing technology provide opportunities for building novel lenses. This presentation reviews the history of lens development, discusses common challenges, and provides insights for new lens designs.

12HS.3

History of Carbon Measurement in Atmospheric Particulate Matter.

STEPHEN MCDOW, Barbara Turpin, *U.S. EPA*

A vast literature now documents the health effects of particulate matter (PM), including cardiac effects, aggravated asthma, decreased lung function, and premature mortality. To better understand these effects and effectively control PM sources, the measurement of particular PM components has been a high priority. Parallel efforts have concerned the role of different PM components in effects on visibility, climate, materials, and ecosystems. Carbon containing species account for a large fraction, if not the majority, of PM mass in many U.S. locations. But carbon in PM is distributed among thousands of individual organic compounds with diverse properties, as well as large amorphous structures of nearly pure carbon, commonly referred to as elemental carbon. Early approaches to quantify organic material in PM involved extraction from glass fiber filters with various organic solvents, but these were time consuming and often hindered by poor extraction efficiencies for some compounds. A more convenient approach was to measure carbon dioxide after combustion of PM collected on quartz fiber filters, either directly using infrared spectroscopy or after reduction to methane using flame ionization detection. Added benefits of this method were: 1) the ability to evaluate for carbon mass closure in comparison to molecular-level analyses, and 2) the separation and analysis of both organic and elemental carbon if changes in filter reflectance or absorption during analysis was monitored. This presentation follows the story of thermal/optical carbon analysis: its early development, challenges separating organic and elemental carbon, addressing organic vapor adsorption artifacts on filters, development of high time resolution methods to study atmospheric processes, incorporation into national monitoring networks for PM speciation trends and atmospheric visibility impairment, and standard development and method harmonization for routine analysis.

12HS.4

Evolution of Computer Controlled Scanning Electron Microscopy for Characterization of Atmospheric Particles.

GARY CASUCCIO, Traci Lersch, Kristin Bunker, Roger West, Long Li, *RJ Lee Group, Inc.*

Scanning electron microscopy (SEM) has been used to characterize atmospheric particles since the 1960s. Combined with an energy dispersive X-ray spectroscopy (EDS) detector, the SEM has evolved into a powerful tool that can provide high-resolution images and elemental composition at the nanoscale, allowing for the collection of detailed information on individual particles. However, although a powerful analytical tool, its application in environmental studies has been limited compared to bulk analytical techniques, due in part, to being perceived as primarily a research tool and not capable of providing quantitative data on particle populations. This limitation was realized early in the development of the SEM and led researchers in the late 1970s to begin exploring the potential of integrating computers and developing software to 'control' the SEM/EDS systems to enable particles to be detected and characterized rapidly and in sufficient numbers to be representative of the entire sample. Over the past four decades, automated SEM analysis, which is often referred to as computer-controlled SEM (CCSEM), has evolved from hybrid 'one-off' research systems to fully integrated systems used routinely in a variety of industrial applications. The evolution of CCSEM parallels advancements in computer technology from mainframe computers to minicomputers to PCs. It also dovetails with the evolution in air quality sampling and analysis, from total suspended particles (TSP) to PM_{10} to $PM_{2.5}$. This presentation will provide an overview of the key developments associated with CCSEM from the perspective of environmental analysis of ambient samples from TSP to $PM_{2.5}$ and will provide a glimpse of where the technology is headed in the not too distant future.

12ID.1
Overview of Respiratory Aerosol Emission Measurements from the University of Bristol AERATOR and PERFORM projects. Justice Archer, F.K.A. Gregson, Allen E. Haddrell, Joshua Harrison, Lauren McCarthy, Henry Symons, Jianghan Tian, Christopher Orton, Natalie Watson, Brian Saccente-Kennedy, Ben Moseley, Ruth Epstein, James Calder, Pallav Shah, Declan Costello, Bryan R. Bzdek, JONATHAN P. REID, *University of Bristol*

Aerosol particles are exhaled during respiratory activities such as breathing while at rest or during exercise, speaking and singing and have the potential to transmit pathogens if emitted from an infected individual. Particle diameters can span more than 5 orders of magnitude and are exceedingly low in concentration when compared to particulate matter concentrations in room air, necessitating measurements in an ultraclean space where participants breathe in clean air. The coronavirus disease (COVID-19) pandemic has reinforced the need to understand respiratory aerosol particle and droplet emission rates.

The University of Bristol Aerosol Research Centre has led and participated in two significant measurement campaigns working with clinicians, and collecting data on respiratory aerosol from almost 300 participants. Now the outcomes of these projects are complete, we will provide an overview of the findings of the studies PERFORM (The Investigation of Particulate Respiratory Matter to Inform Guidance for the Safe Distancing of Performers in a COVID-19 Pandemic) and AERATOR (The AERosolisation And Transmission Of SARS-CoV-2 in Healthcare Settings).

In particular, we will summarise absolute number and mass exhalation rates from combined measurements of minute ventilation using cardiopulmonary exercise testing and exhaled particle concentrations. We will examine the correlation of particle mass emission rate with the flux of exhaled CO2, and summarise studies of droplet size distributions up to and above 100 micrometres diameter. The reduction in aerosol by surgical masks will be reported across a range of speech and language therapy tasks. We will also compare data from healthy adults and children with data from those with pre-existing lung conditions. The outcomes from our measurements with wind instrumentalists will also be summarised, comparing cohorts of trumpet, clarinet and flute players.

12ID.2
Assessing Aerosol Generation from Procedures and Accidents in Biological Laboratories. ASHLEY R. RAVNHOLDT, Danielle N. Rivera, Daniel N. Ackerman, Gabriel A. Lucero, Elizabeth A. Klug, Shanna A. Ratnesar-Shumate, Joshua L. Santarpia, *University of Nebraska Medical Center (UNMC)*

Laboratory-acquired infections (LAIs) pose a significant risk to laboratory workers and can have serious consequences. Aerosols generated during laboratory procedures are considered a significant source of LAIs, but the actual production of aerosols in many standard laboratory procedures and common accidents have not been quantified. In this study, the generation of aerosols during common laboratory procedures and accidents was assessed by conducting selected laboratory actions in a small-volume chamber with an upwelling flow. The chamber is equipped with sampling ports to simultaneously measure aerosol concentration and size distribution using a Next Generation Impactor (TSI Inc.), an Optical Particle Sizer (TSI Inc.), and an 80 mm gelatin filter. The data collected from these measurements can provide insight into the size and quantity of aerosol particles that may be generated from each procedure tested, inform the potential risk during individual procedures, and offer insights for protecting laboratory workers. The results of initial studies using a fluorescent tracer have revealed that laboratory actions can generate aerosols that could result in LAIs. Proposed future work will focus on experiments with bacterial and viral suspensions to demonstrate that infectious agents can be carried by aerosols generated in these activities.

12ID.3

Coughs and Sneezes Spread Diseases. Replication and Modelling of Infectious Airborne Respiratory Droplets. Robert Alexander, Jianghan Tian, ALLEN E. HADDRELL, Henry Oswin, Edward Neal, Jamie Mann, Tristan Cogan, Andrew Davidson, Darryl Hill, Jonathan P. Reid, *University of Bristol*

Determining what contributes to the viability of a pathogen in the aerosol phase is beneficial to forecasting the likelihood of airborne disease transmission and mathematically modeling outbreaks. This research can contribute to public health response for future pandemics and also help tackle endemic diseases in our communities currently.

Pathogen viability measurements made using Controlled Electrodynamic Levitation and Extraction of Bioaerosol onto Substrate (CELEBS) in tandem with comparative kinetics electrodynamic balance (CK-EDB) measurements, allow for direct comparison between viral viability and evaporation kinetics of the bioaerosol droplet as a function of time (Fernandez et al. 2020).

Recent studies suggest that the loss of infectivity of SARS-CoV-2 in the aerosol phase is driven by two mechanisms. Firstly, the phase change associated with a complete drying of the respiratory droplet. Secondly, the non-physiological, high alkaline conditions of a partially evaporated respiratory aerosol. Over the course of the pandemic, as different variants of concern predominated, an aero-stable phenotype was selected for, with viral stability at high pH as the best indicator for aero-stability (Oswin et al 2022). Alternatively, E coli viability decay in the aerosol phase was seen to be driven by oxidative stress, rather than the physicochemical mechanisms described for viruses (Oswin et al 2023).

To be presented is the airborne survival of commensal Neisseria species as a surrogate model for meningococcal disease. The interplay between microphysical droplet dynamics (pH and phase change) and microbial phenotype such as mobility and structure (e.g. capsid) are explored. The project aims to develop a robust model for bacteria-laden respiratory droplets through single-particle electrodynamic levitation experiments.

12ID.4

CFD Modeling of Droplet Transport around a Human Body with Tracer gas, Eulerian, and Lagrangian Models. Donghyun Rim, SEONGJUN PARK, *Pennsylvania State University*

After the outbreak of the COVID-19 pandemic, transport of viral aerosols has been widely modeled using computational fluid dynamics (CFD) simulation based on three approaches: 1) Tracer gas, 2) Eulerian, and 3) Lagrangian. Tracer gas model describes aerosols as a gas phase and Eulerian model assumes continuum particle, while Lagrangian model calculates discrete particle trajectories. However, very little information is available on the advantages and limitations of these models. The objective of this study is to assess the performance of the three approaches in modeling aerosol transport near a human body, considering the effect of the turbulent models, RANS SST k-w model and Large eddy simulation (LES).
The simulations were performed for an occupied room with a size of 5.5 m x 4.5 m x 2.7 m (67 m3), which had one sitting thermal manikin with aerosols (3.2 µm) released about 1.6 m in front of the manikin at an air speed of 0.2 m/s.

The result shows that the tracer gas model overpredicts aerosol concentrations in the human breathing zone (defined as the volume-averaged concentration within a 500 cm3 cuboid below the nose tip of the exposed occupant) about 20% compared to Eulerian and Lagrangian models. This is mainly because diffusion coefficient of the gas phase is about 104 times higher than that of the particle phase, and the gas phase is not affected by the gravitation settling. Eulerian model can be an alternative for Lagrangian model when LES was used for the turbulent model, because eddies created by LES model can simulate the aerosol dispersion near a human body. However, with SST k-w model, Eulerian model shows limitations in simulating the aerosol concentrations in the boundary layer, resulting in a 24% concentration difference in the human breathing zone compared to Lagrangian model.

12NM.1

Direct Carbon Capture Repeatability of Magnesium Oxide (MgO) Nanoparticles Synthesized by Aerosol Methods at Room Temperature.

KYUNGIL CHO, Yeryeong Kang, Jihye Park, Sukbyung Chae, Changhyuk Kim, *Pusan National University*

Climate change has caused more frequent extreme weather events than ever. For mitigating climate change, carbon dioxide (CO_2) should be removed and reduced from the flue gas and the atmosphere. Mineral Carbonation is one of promising direct carbon capture technologies using the alkaline earth metal oxides such as magnesium oxides (MgO). Cho et al. reported that aerosol processed MgO NPs showed direct carbonation with less hydration during the wet based carbonation processes, different with the commercial ones. In this study, the effects of the direct carbonation characteristics of the MgO NPs on the durability of direct carbon capture performance were investigated through repeated carbonation and decarbonation processes.

The MgO NPs were synthesized by two aerosol methods and mixed with D.I. water in flasks for continuous direct carbon capture of pure CO_2 (99.99%). While the carbonation, magnetic stirring was applied for uniform carbonation with constant RPM. pH of the MgO slurries were monitored during the carbonation processes to check the end of the processes. Carbonates were dried in the oven and decarbonated at 800℃ in a furnace. The carbonation and decarbonation processes were repeated up to 15 cycles. The changes of morphology and chemical composition of the MgO NPs and carbonates were analyzed with the carbon capture amounts per unit mass of the adsorbents.

The MgO NP based CO_2 adsorbents showed less hydration and direct carbonation during the repeated carbonation experiments. After the carbonation, the MgO NPs were transformed into pillar shaped carbonates. Interestingly, the carbonates did not return to their original shapes of MgO NPs, even though the chemical compositions were MgO. The decarbonated particles had porous surface pillar shapes, where CO_2 gas molecules were adsorbed during the carbonation processes. The change of CO_2 adsorption capacity for each MgO NP will also be discussed as a function of repeating cycles.

12NM.2

Progress in Aerosol-Based Synthesis of Metal-organic Framework (MOF) Particles in Supercritical CO2.

IGOR NOVOSSELOV, *University of Washington*

The high surface areas and tunable porous structures of Metal-Organic Framework (MOF) materials offer desirable capabilities in a wide range of applications. One challenge to the widespread use of MOFs is a lack of large-scale manufacturing synthesis processes. The aerosol-based method allows for rapid single-step synthesis and activation of MOFs. We present an overview of a novel method of continuous synthesis of MOF in supercritical carbon dioxide (scCO2) environment. The rapid mixing of precursors into scCO2 provides a single-phase environment that enhances heat and mass transfer during the synthesis. The method synthesized the zirconium-based MOF UiO-66 at a production rate of 104 g/h [1]. Synthesis of UiO-66 was confirmed via SEM images, powder X-ray diffraction (PXRD) spectra, and physisorption analysis. Additionally, testing showed that this method could be used to activate as well as continuously synthesize MOF materials. Additionally, the method was applied to synthesize other MOFs: HKUST-1 [2] and SBMOF-1, demonstrating the practicality of continuous flow scCO2 MOF synthesis. BET area and particle size can be optimized by manipulating reactor operating temperatures and CO2 fraction in the reactor. The best quality MOFs were obtained when conditions for a single-phase supercritical mixture were met. The method results in rapid reaction time (<3s), can be easily scaled, and it allows for the recovery of effluent and unreacted material, which is challenging in hydrothermal and supercritical water-based systems.

[1] E. G. Rasmussen, J. Kramlich, and I. V. Novosselov, "Scalable Continuous Flow Metal–Organic Framework (MOF) Synthesis Using Supercritical CO2," ACS Sustainable Chemistry & Engineering, vol. 8, no. 26, pp. 9680-9689, 2020/07/06 2020, doi: 10.1021/acssuschemeng.0c01429.
[2] E. G. Rasmussen, J. Kramlich, and I. V. Novosselov, "Synthesis of metal-organic framework HKUST-1 via tunable continuous flow supercritical carbon dioxide reactor," Chem. Eng. J., vol. 450, p. 138053, 2022/12/15/ 2022, doi: https://doi.org/10.1016/j.cej.2022.138053.

12NM.3

Aerosol-Based 3D Printing Technology for High-Resolution Printing of Single and Composite Materials. SHALINEE KAVADIYA, Pratim Biswas, *University of Miami*

The demand for miniaturization is growing in medical, electronics, military, and aerospace industries. For example, micro-robotic devices, which can travel throughout the body and function in delicate and hard-to-reach places, are becoming popular. Due to this downsizing of devices, designers and product developers must innovate on traditional design practices. Miniature device fabrication requires techniques that can achieve such small dimensions. The conventional techniques of multi-step micro-electromechanical system technology and template-assisted layer-by-layer assembly are effective but complex, time-consuming, and lack printing features smaller than a few tens of micrometers. 3D printing has become more popular for fabricating small devices because of its simplicity, autonomy, and excellent reproducibility.

Microdevice 3D printing methods include two-photon polymerization (2PP), stereolithography (SLA), direct light processing (DLP), continuous liquid interface production (CLIP), and selective laser sintering (SLS). These laser-based methods provide good resolution but need several steps and degrade material with high-energy lasers. SLA, 2PP, DLP, and CLIP can only print photopolymer. SLS needs a thin bed of powder, which is challenging to handle, especially with nanoparticles, resulting in the use of big particles (> 25 µm) and reduced printing resolution.

We are developing a simple aerosol-based 3D printing (A3DP) technology that can print small-length scales (< 50 µm) without any special environment during printing. The printing feedstock is generated using an aerosol process which enables printing finer length scales. Further, the feedstock can be controlled at any time to print the desired resolution and material. We printed a variety of materials: polymers, polymer–metal oxide composite, polymer–metal nanoparticle composite, and graded materials. In the presentation, we will demonstrate its capabilities to print these materials and discuss important parameters for high-resolution printing using the A3DP process.

Reference

[1] Kavadiya and Biswas (2023), Aerosol-based 3D printing technology for high resolution and precision printing, in preparation.

12NM.4

Quantifying the Chemical Composition and Mass Concentration of Nanoplastic Particles in the Atmosphere Using Real-time Mass Spectrometry. Sining Niu, Sahir Gagan, Alana Dodero, Zezhen Cheng, Ruizhe Liu, Xingmao Ma, Qi Ying, Manjula Canagaratna, YUE ZHANG, *Texas A&M University*

Nanoplastics have been shown to not only have adverse implications on human health and the ecosystem, but also contribute to climate forcing. Despite being increasingly important, there is no real-time detection of atmospheric nanoplastic particles (NPP) while previous offline methods often require days to weeks of collection.

Herein, we provide the first study to quantify real-time nanoplastics concentrations in the atmosphere and their chemical reaction process. A high-resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS) is employed to detect submicron polystyrene (PS) particles, one of the most abundant plastics produced. A calibration curve is established and tracer ions, including m/z 74 and 104, are shown to be unique to PS particles.

Ambient particles are also collected and analyzed by a constrained PMF (multilinear engine, ME-2) method to determine the temporal distribution of microplastic particles. A distinct factor that is highly correlated to the pure PS profile is separated. The mass concentration of PS nanoplastic particles is estimated to be 10-50 ng m^{-3} with a detection limit of 3 ng m^{-3} during our sampling periods in Texas.

In addition, the aging of PS particles reacting with hydroxyl radicals (OH·), ozone, and UV light are characterized using a Potential Aersosol Mass (PAM) reactor. The pseudo first order rate constant of PS particles against OH· radicals is calculated to be 1.374×10^{-13} cm^3 $molecule^{-1}$ s^{-1} while the ozonolysis and photolysis rates were negligible. The half-life time of microplastic in the atmosphere is estimated to be less than 84 days, significantly shorter than their marine lifetime. Microscopic measurements also demonstrate that the NPP become more hygroscopic after aging, suggesting changes of their climate properties.

The above results may bridge important gaps in understanding the long range transportation abilities, environmental persistence, health implications, and potential climate forcing of the NPP.

12RA.1

Quantification of Anthropogenic and Pyrogenic Particulate Bromine by Aerodyne Aerosol Mass Spectrometer (AMS).

DONGWOOK KIM, Pedro Campuzano-Jost, Hongyu Guo, Benjamin A. Nault, Douglas A. Day, Melinda Schueneman, Jason Schroder, Josh DiGangi, Sally Pusede, Glenn Diskin, Donald Blake, Jack Dibb, Rainer Volkamer, Jose-Luis Jimenez, *University of Colorado, Boulder*

Gas-phase bromine is important for ozone chemistry in both the troposphere and the stratosphere. Recent studies have shown that reactive bromine species could worsen air quality in urban areas by enhancing O_3, secondary organic aerosols, and nitrate formation. Particulate bromine can be a reservoir for reactive bromines in the atmosphere. However, due to a lack of measurements with high sensitivity and fast time resolution, concentration and sources of particulate bromine are currently not well-constrained in chemical transport models (CTMs). Current emission inventories used in CTMs assume that bromine is predominantly emitted from marine sources. We have retrieved new submicron particulate bromine data products from the highly customized CU-Boulder Aerodyne Aerosol Mass Spectrometer (AMS) measurements. The specificity of the AMS response to particulate bromine and its good agreement with filter-based bromide measurements is demonstrated. We present particulate bromine measurements for urban, remote, and wildfire-impacted airmasses sampled during the KORUS-AQ, TI^{3}GER, and FIREX-AQ aircraft campaigns. We have identified sources that were previously not well recognized. The measurements suggest primary emission of particulate bromine from anthropogenic and pyrogenic sources, based on the strong correlation with combustion tracers. We find that particulate bromine could be the major form of bromine emission from US wildfires, larger than more commonly measured gas-phase species. Anthropogenic particulate bromine emissions in highly polluted Asian urban areas are identified and likely to affect urban air quality. We also discuss the contribution of anthropogenic and pyrogenic bromine sources to the global bromine budget based on the bromine-to-CO emission ratios.

12RA.2

Numerical Study of the Impact of Dust-PM10 on VOCs Reduction in Coniferous Forest.

BORIS KRASOVITOV, Rahul Tarodiya, Andrew Fominykh, Avi Levy, Itzhak Katra, *Ben-Gurion University of the Negev, Israel*

Biogenic Volatile Organic Compounds (VOCs) are released by the forests. Forests also affect airflow and particulate matter (PM) concentration in the atmosphere. In this study, we performed a numerical analysis of the adsorption of VOCs above and inside coniferous forests by dust-PM10. The developed model is based on the application of theory of turbulent diffusion in the forest combined with the model of dust particles deposition to vegetation elements and VOCs adsorption by airborne dust particles. 3D modeling of the particulate flow using a discrete phase model, based on the Eulerian-Lagrangian approach, has been performed to investigate the dust deposition on the tree leaves. The modeling considered several forces influencing the particulate motion, namely, the drag force, buoyancy force, Brownian force, and Saffman's lift force, along with a methodology to capture the particle deposition on the vegetation element, which is considered as a prolate ellipsoid approximating in shape to a leaf of coniferous trees (needles). Based on Computational Fluid Dynamics (CFD) modeling, the novel parameterization of the average particles collection rate is suggested. The validity of the model prediction is evaluated by comparison of the model of particle deposition on a Forest Canopy (PDFC) supplemented by parameterization of the average collection rate based on the CFD model with field measurement data. Further, the influence of particle size and wind velocity on VOCs reduction in coniferous forest are analyzed. It is observed that despite a significant decrease in the PM concentration along the forest, dust particles can reduce the concentration of VOC by 7-9 % on the leeward side of the forest. The results of the present study may help expand our knowledge on the spatial interaction of gases and solid particles in the atmosphere to provide more realistic estimates of the contribution of VOCs to the formation of ground-level ozone.

12RA.3

A Study on the Evolution of Smoke from Prescribed Fires in Southeastern US. RIME EL ASMAR, Rodney J. Weber, M. Talat Odman, Greg Huey, David Tanner, Zongrun Li, *Georgia Institute of Technology*

Increasing wildfires in the US are emitting high amounts of pollutants. The negative impact of emissions on air quality may be reduced by using prescribed burning as a fire management tool to limit the occurrence of wildfires. While prescribed burning can be controlled, it can still substantially contribute to air pollution due to emissions of particulate matter (PM) and hazardous gaseous compounds. In this work, we studied smoke from prescribed fires of forested training lands at Fort Benning, Fort Stewart, and Eglin Air Force Base, located in the Southeastern US, during the burning seasons of 2021, 2022, and 2023. We measured CO, O_3, NO_x, $PM_{2.5}$ mass, and BC, and inferred brown carbon (BrC) from multiwavelength aethalometers. Our approach to study smoke emissions at Fort Stewart and Eglin was to move and locate instruments across smoke receptor areas predicted by models just prior to burning events. At Fort Benning, we located five instrumented trailers in different sites throughout the fort, based on a burning plan set prior to the burning season and sampled continuously throughout the burning season. Smoke age, estimated based on fire and wind data, was used to study the evolution of O_3, $PM_{2.5}$, and BrC. For smoke of different ages, consistent O_3 enhancements relative to CO were observed during photochemically active periods. $PM_{2.5}$ mass and BrC relative to CO were higher for smoke transported 1-4 hours relative to fresh smoke less than 1 hour old. This indicates secondary $PM_{2.5}$ formation, including BrC species. The goal of this work is to provide data on prescribed fire emissions and smoke evolution for the testing and development of models used in burning management to decrease their adverse air quality impacts.

12RA.4

Comparison of Biases in Filter-Based Aerosol Light Absorption Measurements over a Rural and Urban Area. JOSHIN KUMAR, Nishit Shetty, Patrick Sheridan, Allison Aiken, Manvendra Dubey, August Li, Ganesh Chelluboyina, Benjamin Sumlin, Joseph V. Puthussery, Rajan K. Chakrabarty, *Washington University in St. Louis*

Measuring aerosol light absorption is crucial to assess direct radiative forcing that impacts local and global climate. At the ARM Southern Great Plains (SGP) site, light absorption by aerosols has been continuously measured using a three-wavelength (467, 530, and 660 nm) Particle Soot Absorption Photometer (PSAP). While filter-based instruments like the PSAP are low-cost and simple to operate, they suffer from unquantifiable artifacts due to the filter medium and complex interactions between filter fibers and deposited aerosols.

Various correction algorithms (Bond et al., 1999; Virkkula et al., 2005; Li et al., 2020) have been introduced to correct for the filter-based absorption coefficient measurements toward predicting the particle-phase absorption coefficient (Babs). These algorithms have a fixed analytical form, which limit their universal applicability across diverse environments (e.g. rural, urban, marine).

In this study, we analyze and compare aerosol light absorption measurements over the rural SGP site and the urban La Porte area of Texas (site of TRACER campaign), respectively, using ARM's PSAP and PI-deployed guest instruments, namely, multiwavelength photoacoustic spectrometers (PASS). Photoacoustic spectroscopy is a first-principles measurement technique of particle-phase Babs. We find that the PSAP overestimates the absorption measurements by a factor of four and three, respectively, over the SGP and La Porte sites in comparison to PASS measurements.

To correct for this overestimation in PSAP measurements, we implemented the widely used Virkkula/Bond analytical correction algorithms, as well as a Random Forest Regression (RFR) machine-learning algorithm. Our results show that the RFR algorithm significantly outperforms the extent of corrections achieved using the Virkkula/Bond algorithms.

By applying the RFR algorithm, the wavelength averaged Root Mean Square Error (RMSE) for predicting particle-phase Babs is reduced by approximately 88% and 60% of the RMSE of the Virkkula algorithm at the SGP and La Porte sites, respectively. The RFR algorithm predicted Babs values within approximately 25% and 40% of the reference Babs measured by the multiwavelength PASS at SGP and La Porte sites, respectively.

Machine learning offers a promising path to correct for biases in long-term filter-based absorption datasets and accurately quantify their variability and trends needed for robust radiative forcing determination.