Plenary I: AEESP Lecture

Wash Day: Supporting Air Justice. SHIRLEY MALCOM, *American Association for the Advancement of Science*

As a child growing up in Birmingham, Alabama, in an intergenerational household, there was a routine to our lives, including when the laundry was done. Monday was Wash Day. The old agitator washer was moved from the back porch to the kitchen with easy access to the sink for rinsing the clothes that, in good weather were then hung on clothes lines in the back yard. Of course, when it rained, or on “bad air days” wash day might be postponed. Bad air days, often exacerbated by a temperature inversion, were routine in our lives as well, by way of Birmingham’s steel mills, coke plants and other heavy industry, and made worse because of Birmingham’s topography, sitting as it did in Jones Valley. Clothes hung outside on a bad air day were quickly dirtied.

I experienced Los Angeles’ pollution during graduate school in the late 1960s and early 1970s. But it was while serving on the board of the Heinz Endowments that I was brought full circle from the Pittsburgh of the South to Pittsburgh, where I was able to gain a new perspective on bad air, its disproportionate effect on the health and education of minoritized and poor communities and its connection to structural inequalities. I also gained insights on what communities could do to mitigate the impacts-- seeing the science, communications and community empowerment come together. In this presentation, I will share my personal journey of awakening to environmental justice and injustice and what these mean for the science community.

Plenary II: Lundgren-Marple Lecture

Atmospheres and Aerosols of Other Worlds. JAMES CUTTS, *Jet Propulsion Laboratory*

The identification of atmospheres and aerosols on Mars, Venus and Jupiter was made by astronomers in the pre-spacecraft era. However, while knowledge of the nature of the atmospheric gases was rapidly established, determining the composition of aerosols has proved more elusive. Flyby and orbital spacecraft observed the target from afar with remote sensing techniques. Vehicles that descended into the atmospheres were fewer and most were not equipped to characterize aerosols. Thus, when the Planetary Science and Astrobiology Decadal Survey compiled a comprehensive report on the state of this research field it concluded that “Aerosols (dust, hazes, and clouds) are key features of many planetary atmospheres and affect the atmospheric absorption and scattering of solar radiation. Aerosol transport, microphysics, and radiative processes are often coupled via complex feedbacks, yet few measurements related to such processes exist for atmospheres other than Earth’s”. This presentation will review what is currently known about aerosols on other worlds and what future missions may tell us for worlds in our solar system and beyond. We will stress the importance of new exploration platforms such as rotorcraft and balloon, advances in miniaturized aerosol instrumentation suitable for planetary missions and the importance of earth based experimental facilities such as the Planetary Cloud and Aerosol Research Facility (PCARF) currently under construction at JPL. Finally, we will cover the mysteries of the aerosols that constitute the clouds of Venus, what is known today, what the Rocket Lab Venus probe planned for launch in 2025 may tell us and the role of long duration balloon equipped to conduct aerosol mass spectrometry may tell us about the possibility that the Venus clouds may harbor microbial life in a form that is unknown on Earth.

Plenary III: Friedlander Lecture
Don’t Hold Your Breath! Tissue Chips and Other In Vitro Models for Studies of Inhalation Toxicology.

IVAN RUSYN, *Texas A&M Univerisity*

Inhalation toxicology is a study of adverse impacts of gases and aerosols on humans and animals. It is one of the most challenging areas of study in toxicology, but also one of the most important as all humans are exposed to air pollutants and toxics in their daily lives. The challenges range from characterization of the chemical composition of the atmospheres that are inhaled, to understanding of the portal of entry and systemic concentrations and effects of inhaled substances, to making decisions about safe exposure levels for the highly dynamically changing mixtures of potential toxicants. To address these, and other challenges, inhalation toxicology studies typically rely on a range of experimental models and exposure settings, some may be conducted in humans and animals, but many include studies of cells. The latter includes recent developments of complex tissue-like constructs commonly referred to as tissue chips. This presentation will describe some of the new approach methods in inhalation toxicology. While exciting discoveries have been made, there are also great challenges in moving these models from discovery into practice. By presenting both sides of the topic, this plenary should stimulate inter-disciplinary thinking to bridge aerosol research with biomedical science and ultimately yield innovative solutions for regulatory adoption.

Plenary IV
A Perspective on Bioaerosol Research: Interdisciplinary Bridges Connecting Pollen, Pandemics, and Precipitation.

J. ALEX HUFFMAN, *University of Denver*

The interdisciplinary nature of bioaerosol study demonstrates both the complexity and importance that this class of aerosols have with our environment and health. Even defining the scope of bioaerosol research is challenging due to its multifaceted nature, spanning diverse motivations and communities. Airborne bacteria, spores, and pollen exert far-reaching influence on natural ecological systems, climate change, and the hydrological cycle. From combating infectious diseases and biowarfare threats to managing seasonal allergies and agricultural crop health, bioaerosols impact nearly all sectors of society and human health. Yet, deeper understanding continues to be challenged, in part, by disconnects between diverse researcher communities and the disparity between scientific questions that drive investigations.

Over the past quarter-century, notable surges of interest have pushed bioaerosol science forward and often into the forefront of the public’s awareness of scientific research. Each surge has also helped foster new connections between ideas and scientists, introduced new techniques, and amplified both opportunities and challenges within the field. Throughout that arc, the American Association of Aerosol Research (AAAR) has been pivotal in advancing bioaerosol science by offering perspectives from deep expertise in the intertwined disciplines necessary to sufficiently understand aerosols. The COVID-19 pandemic has further underscored the complexity of aerosol dynamics and their critical role in disease transmission and public health. Over the last three years, countless AAAR members have worked tirelessly to play crucial roles in driving transformative science, advocating for scientific understanding, and educating the public.

The timing seems opportune to pause and reflect on some of the historical context for the growth in bioaerosol research and recent advancements, both within AAAR and more broadly. While the invitation to address this broad topic is daunting, the talk aims to shine a light on victories and advances of bioaerosol research and to pull in anecdotes from still more experienced researchers for illustration. The goal is to provide both perspective for the contributions AAAR and its members have made to this critical sector of scientific and societal progress and to inspire younger scientists to embrace the non-linear, but interconnected path of aerosol research.

1AA.1 – INVITED

Using Bioaerosol Sampling as Part of a One Health Integrated Risk Assessment for Pathogen Transmission in Animal Livestock Settings. BENJAMIN ANDERSON, *University of Florida*

Pathogens transmitted within and between animal livestock settings pose significant risks, not only to animal health and productivity, but also to human health when zoonoses occurs. Agricultural workers are at the greatest risk for zoonotic pathogen exposures due to their close contact with animals but can also transmit pathogens to the animals through reverse zoonoses. Despite the increased burden of infectious diseases in these environments, conducting regular surveillance in these settings to understand transmission dynamics can be difficult due to concerns in biosecurity, potential disruptions to normal farm operations, and economic losses. Non-invasive bioaerosol sampling is a way to overcome these challenges. In our research, we utilize bioaerosol sampling techniques as part of a One Health integrated risk assessment strategy that identifies, characterizes, and assesses potential transmission risk of pathogens of concern in livestock environments. Coupled with an approach that trains farm operators to perform sampling directly to maintain proper biosecurity, the outputs from this integrated approach can better inform the development of targeted intervention strategies to mitigate the spread of infectious diseases in livestock settings and can even serve as an early warning system for potential infectious disease outbreaks. Overall, this work highlights the importance of incorporating non-invasive environmental sampling techniques, such as bioaerosol sampling, into comprehensive surveillance programs and demonstrates how the One Health approach is critical in addressing complex health challenges at the human-animal-environment interface.

1AA.2

Antibiotic Resistance Genes from Agricultural Bioaerosols: A Major Eastern Canadian Study. CAROLINE DUCHAINE, Nathalie Turgeon, Mahsa Baghdadi, Joanie Lemieux, Samantha Leclerc, Matthieu Girard, Patrick Brassard, Stéphane Godbout, *Université Laval*

A Canadian national initiative, aiming to study the antimicrobial resistance genes (ARG) in bioaerosols in Canadian arctic, rural and urban environments: sources, profiles, transport and fate was funded by the 2019 NSERC Discovery Frontiers program. This project has led to significant air sampling campaigns in agricultural settings, including poultry, swine and fish farming and during manure spreading activities, providing rich information on bioaerosol emissions from agricultural activities with emphasis on antibiotic resistance genes.

Method. Air samples have been collected from indoors and outdoors farming activities and used to calculate emission rates of ARG. Geolocation, weather data and building ventilation characteristics were included in the collected data. A high throughput PCR assay was also developed to increase analytical capacity.

Findings. Agricultural activities are important emitters of ARG and emission rates can reach significant levels, such as 10^9 ARG/kg of manure spread. Data will be used for dispersion modeling, risk assessment models, and in vivo ARG transfer. Data curation was put together through an extensive database and sample preservation system to ensure the sharing of information and material for future collaborations.

Implications. This project is the first initiative to cover broad sources of bioaerosols and integrate the findings into models to understand better the role of air in the dispersion of ARG. The presentation will cover the methods, context and possibility of collaborations for future valorization of samples and data in order to better understand the contribution of agriculture in ARG dispersion through bioaerosols.

1AA.3

Surveillance of Coccidioides in Aerosols in Arizona. AMELIA STOUT, Marieke L. Ramsey, Daniel R. Kollath, Megan C. Ruby, Bridget M. Barker, Pierre Herckes, Matthew Fraser, *Arizona State University*

Valley fever is an infection caused by the fungus *Coccidioides* in the lungs. Valley fever can cause many acute health problems in humans and animals, such as fatigue, cough, and shortness of breath, and in severe cases, can even cause long-term problems with the lungs and nervous system. To date, nearly all of the research on *Coccidioides* has been based on clinical studies. This study looks at the presence of *Coccidioides* in the air, soil, and burrow systems at a site in Mesa, Arizona. The primary transport mechanism of Valley Fever into humans is inhalation of the fungus through aerosol dust. The focus of this presentation will be on the aerosol samples collected during the first year of sampling. Aerosol samples were collected for 24 hours every 6 days, following the Environmental Protection Agency sampling schedule. Quartz fiber filters were used to determine PM10, key ions, and organic and elemental carbon. Cellulose filters were used to analyze key elements. Gravimetric mass was determined to quantify the total amount of PM10. Ion chromatography was used to determine concentrations of key ions on quartz fiber filters. Organic carbon and elemental carbon were quantified by thermal optical absorption. Key elements were analyzed by hydrofluoric acid digestion followed by ICP-MS. *Coccidioides* were detected frequently in the air. The detection was more likely to occur during high PM10 days. Overall PM10 concentrations at the site were low for the region. The chemical measurements showed little anthropogenic impact. The chemistry will be discussed relative to the detection of *Coccidioides*. This study aims to deepen the understanding of the presence and transport of Valley fever in the desert southwest.

1AA.4

Measurement of Airborne DNA to Detect Arthropods Using Portable Particle Sampling. SHALLON MUTSA JOZI, Amira Hansch, Nicolas Gustafson, Scotty Yang, Roger Schürch, Gabriel Isaacman-VanWertz, *Virginia Tech*

Measurements of atmospheric constituents are often made with complex, expensive instrumentation that provides high chemical detail but is limited in its portability and requires high expense (e.g., mobile labs) for spatially resolved measurements. We recently demonstrated simple, portable devices that can sample with limited operator presence to enable temporally and/or spatially resolved measurements. In this work, we present a revised version of these new portable and programmable samplers for collection of atmospheric particles. We demonstrate simultaneous collection of samples across a spatially distributed network of transects across a targeted area, validate their reproducibility, and demonstrate their utility. Samples are analyzed for airborne eDNA contained within atmospheric particles. By using DNA metabarcoding to identify arthropod species from the collected samples, the presence of specific agricultural pests. Using a novel method for back-projection, we reconstruct a 2-dimensional map of insect locations from the time-integrated transects. This approach has the potential to revolutionize how agricultural pests are identified and located and biodiversity data is collected. Data presented here focuses on validation within constrained environments of known arthropod populations (i.e., bees), but extension to field conditions and agricultural pests will be discussed.

1AA.5

Pig and Broiler Chicken Farm Fan Exhaust Air Sampling as a Proxy for Indoor Air Bioaerosol Microbiota. JOANIE LEMIEUX, Asmaâ Khalloufi, Marc Veillette, Valérie Létourneau, Nathalie Turgeon, Marie-Lou Gaucher, Caroline Duchaine, *Université Laval*

Introduction. Incidence of zoonotic diseases is expected to increase in the coming years, imposing the reinforcement of biosecurity measures for confined animal feeding operations (CAFOs). Infectious diseases may be transmitted via the airborne route, necessitating bioaerosol sampling. In this context, access to CAFOs can be denied. It is necessary to find an alternative strategy for monitoring indoor bioaerosols.

Objectives. Compare bacterial diversity and quantify microbial markers in indoor and at fan exhaust air of ten pig finishing buildings (PFB) and two broiler chicken barns (BCB) in the province of Québec, Canada.

Methods. Bioaerosols were collected using SASS® 3100 Dry Air Sampler indoor (10 m^3) and at the fan exhaust (20 m^3). PFB and BCB were visited at least once during warm season (high ventilation rate). Total DNA was extracted from filters and used for performing amplicon-based sequencing to describe bacterial diversity and qPCR quantification of bacterial and archeal 16S rRNA genes, *Enterococcus* spp., a phage of *Aerococcus viridans* and swine and poultry DNA.

Results. Bacterial diversity between indoor sites and their corresponding fan exhaust was not statistically different (p-value = 0.986). The concentrations of bacterial 16S rRNA genes were not significantly different between samples collected indoor and at the fan exhaust for both PFB (p-value = 0.104) and BCB (p-value = 0.1563). Correlations between sampling sites were strong for *Archaea*, *Enterococcus* and *A. viridans* phage concentrations (r = 0.9203, 0.6091 and 0.7727, respectively). Poultry and swine DNA concentrations at fan exhaust did not correlate with indoor. However, it was possible to detect them at fan exhaust even at low indoor concentrations.

Conclusion. Microbiota emitted by exhaust fans appears to closely resemble the one within CAFOs, even for low-concentration qPCR targets. Air sampling at fan exhaust provides an alternative to reveal indoor airborne microbiota when access to CAFOs is restricted.

1AA.6

Canada at the Forefront of Agricultural Aerosol Research. STÉPHANE GODBOUT, Caroline Duchaine, Shelley Kirychuk, James Dosman, Patrick Brassard, Valérie Létourneau, Nathalie Turgeon, Araceli Dalila Larios Martínez, Bernardo Predicala, Lifeng Zhang, Matthieu Girard, *Research and Development Institute for the Agri-environment*

Aerosols are ubiquitous in agriculture, especially in livestock operations and can affect the health of workers, animals, and surrounding rural communities. Inside buildings, workers may develop infections and non-infectious respiratory diseases (e.g., lung function reduction, asthma, chronic bronchitis, hypersensitivity pneumonitis). The spread of airborne transmissible animal diseases through aerosols can also have devastating economic impacts on the industry. Once emitted into the environment, these contaminants can also affect rural populations. Furthermore, the widespread use of antibiotics in livestock operations, in therapeutic and subtherapeutic doses, is associated with the selection and multiplication of antibiotic-resistant pathogens, further exacerbating the issue.

Studying aerosols and addressing the health risks is particularly challenging in agriculture due, among other factors, to the relatively low concentrations, the diversity of microorganisms and the scale of potential sources. A national initiative has been put in place in Canada by the Canadian Centre for Rural and Agricultural Health (CCRAH) at the University of Saskatchewan to better understand aerosols in agriculture and accelerate the implementation of mitigation strategies. This multi-million-dollar initiative was financed by the Government of Canada and includes over a dozen researchers from 7 different research institutions (see list below). The project is managed by Agrivita Canada Inc., a not-for-profit company established in 2007, that stimulates, supports, and leads applied safety and health research and development aimed at sustainability and productivity in Canadian agriculture.

A 5-year project recently concluded that produced a wealth of knowledge. For example, emissions of dust and bioaerosols following manure spreading were extensively analysed, both in a full-scale wind tunnel and in the field. The impact of new efforts to improve animal welfare on the health and safety of workers was also investigated for poultry, dairy and swine operations. Air quality reference values were determined for both conventional systems and next-generation buildings integrating animal welfare considerations.

1AC.1

Monitoring Early-Generation Formation and Gas-to-Particle Phase Partitioning of Isoprene Oxidation Products by Ion Mobility Spectrometry Coupled to High-Resolution Chemical Ionization Mass Spectrometry. REBECCA L. RICE, Molly Frauenheim, Matthieu Riva, Peter Mettke, Hartmut Herrmann, Siddharth Iyer, Sebastian Gerber, Stephan Graf, Felipe Lopez-Hilfiker, Michael Kamrath, Jason Surratt, Zhenfa Zhang, Avram Gold, *University of North Carolina at Chapel Hill*

Isoprene is the largest non-methane volatile organic species emitted into Earth's atmosphere. Isoprene oxidation by hydroxyl radicals yields low- and semivolatile oxygenated molecules that form secondary organic aerosol (SOA), which contributes to fine particulate matter. The inability of conventional mass spectrometric techniques to distinguish between isomeric species in the gas phase has posed a formidable challenge to understanding the gas phase processes in isoprene oxidation leading to SOA. In particular, the evolution of early generation isoprene oxidation products and the formation, uptake, partitioning and fate of semivolatile products remains poorly described. The recent availability of Chemical Ionization-Structures for Lossless Ion Manipulation-Ion Mobility Spectrometer-High Resolution Mass Spectrometer (CI-SLIM-IMS-HR-MS) enables separation of gas phase isomer mixtures has shown promise to advance understanding of gas phase processes and greatly improve predictive SOA modeling. We report here initial experiments coupling CI-SLIM-IMS-HR-MS to a smog chamber to monitor OH-mediated oxidation of isoprene in a low-NOx regime and to investigate partitioning and fate of semivolatile uptake products. We present real-time traces of ISOPOOH and IEPOX isomers. We have previously shown that the C5H8O3 products originally assigned as δ-HPALDs are cyclic peroxyhemiacetals and for the first time, we directly compare the relative rates of formation of these early generation gas phase products. We have shown that in-particle rearrangement of IEPOX on uptake yields the semivolatile compounds 3-methyltetrahydrofuran-2,4-diol and 3-methylenebutrane-1,2,4-triol (formerly C5-alkene triols). We monitor IEPOX uptake by (NH4)2SO42– at pH 1.4 and 3.5 by CI-SLIM-IMS-HR-MS in the gas phase and HILIC/(-)-ESI-HR-ToF-MS in the particle phase and estimate partitioning. Furthermore, we show that the proportion of rearrangement products is highly sensitive to particle pH as well as relative humidity. The uptake experiments provide insights into the disparate results reported for relative yields of “C5-alkene triols" and 2-methyltetrols in field studies.

1AC.2

Constraining Gas Phase Yields and Reactive Uptake Coefficients of Isoprene-OH Oxidation Products onto Acidic Particles by Vocus Ammonia-Adduct Chemical Ionization Mass Spectrometry (Vocus NH4+ CIMS). Jiayun Zhao, Sahir Gagan, Molly Frauenheim, Sining Niu, Jason Surratt, Zhenfa Zhang, Avram Gold, Renyi Zhang, YUE ZHANG, *Texas A&M University*

Isoprene, the most abundant non-methane volatile organic compound in the atmosphere, undergoes photochemical reactions with OH, a major sink for isoprene, leading to the formation of secondary organic aerosols (SOA). Using Vocus Chemical Ionization Mass Spectrometer CIMS with ammonium-adduct ions (Vocus NH_4^+ CIMS), this presentation provides new insights on the yield and reactive uptake of oxidized volatile organic compounds (OVOCs) produced from isoprene-OH oxidation under dry conditions.

Multiple epoxides that are not the typical isoprene epoxydiols (IEPOX) were identified during the isoprene photooxidation chamber experiments. The molar yields of key oxidation products are quantified with sensitivities estimated from an innovative voltage scan of the front and back end of ion-molecule reactor region of the Vocus. The reactive uptake coefficients (γ) for key isoprene-OH oxidation products onto acidic particles, including non-IEPOX epoxy molecules, are quantified by combining chamber experiments with detailed box modeling. The γ values for $C_5H_{10}O_3$ (IEPOX/ISOPOOH) and $C_5H_8O_4$, an non-IEPOX epoxy molecule, demonstrate rapid decrease as the SOA coating thickness increases, suggesting a self-limiting effect.

Despite ISOPOOH/IEPOX contributing around 80% to total reaction uptake, other oxidation products from isoprene photooxidation, including those non-IEPOX epoxy molecules, still contribute 20% of the total SOA formation. These findings highlight the importance for future models to consider the self-limiting effects of ISOPOOH/IEPOX and SOA formation through non-IEPOX pathways.

1AC.3

Kinetic Investigation of Secondary Organic Aerosol Formation of Products from Isoprene and Alpha-Pinene Oxidation. PETER METTKE, Laurent Poulain, Andreas Tilgner, Anke Mutzel, Martin Brüggemann, Hartmut Herrmann, *Leibniz Institute for Tropospheric Research*

Isoprene and monoterpene oxidation have been shown to contribute significantly to the formation of secondary organic aerosol (SOA) in recent decades. However, the involved SOA formation pathways are not clearly understood leading to large discrepancies in observed and predicted formation rates and spatial distributions of SOA by atmospheric chemistry models.

Isoprene hydroxy hydroperoxides (ISOPOOH) are the main first-generation products of isoprene OH oxidation in rural areas. Further oxidation leads to the formation of highly oxidized ISOPOOH oxidation products, that have been identified as important SOA precursors previously. Similarly, oxidation products of α-pinene have been shown to make up large fractions of SOA. Nonetheless, kinetic investigations of the corresponding SOA formation processes are largely missing, leaving huge uncertainties in evaluating their impact on atmospheric chemistry, and thus, its implications for climatic processes.
Within the present work, the two most abundant isomers of isoprene-derived hydroxy hydroperoxides (ISOPOOH) have been synthesized using a novel synthetic procedure. The products were characterized using nuclear magnetic resonance (NMR) spectroscopy and online MS techniques, namely PTR-ToFMS, AMS and CI-APi-ToFMS. Moreover, to elucidate gas-particle interactions, the partitioning behaviour of 1,2-ISOPOOH was investigated in more detail for various seed particles. For acidic seed particles an uptake of 1,2-ISOPOOH with a specific uptake coefficient of $\gamma=(9\pm4)\times10^{-3}$ was observed.

Furthermore, the OH oxidation of 1,2-ISOPOOH as well as α-pinene under low-NO_x conditions was studied. The formation of numerous highly oxygenated organic molecules was observed. Subsequently, the uptake coefficients of the individual compounds were determined for two different seed particle compositions for both precursor compounds and analysed using a resistance model which considers limitations by gas- or particle-phase processes. Finally, overall trends for specific uptake coefficients depending on molecular properties, such as vapor pressure, molecular mass or their respective O/C ratio were investigated.

1AC.4

Synthetic, Experimental, and Computational Constraints on Pinene Secondary Organic Aerosol Formation. CHRISTOPHER KENSETH, Jing Chen, Olivia Hakan, Nathan Dalleska, Henrik Kjaergaard, Brian Stoltz, Paul Wennberg, John Seinfeld, Joel A. Thornton, *University of Washington*

For decades, advanced mass spectrometric techniques have been employed to infer structures and develop formation mechanisms of molecular products in secondary organic aerosol (SOA) derived from the oxidation of pinene. These structures and mechanisms have been widely adopted (e.g., in explicit chemical mechanisms) yet remain largely unconstrained, leading to potential misinterpretation and significant uncertainty with respect to the composition, properties, and associated impacts of pinene SOA. In this work, 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 laboratory experiments featuring a selectively deuterated α-pinene isotopologue and using iodide-adduct chemical ionization mass spectrometry (I-CIMS) and LC/ESI-MS for analysis of molecular composition together with quantum chemical calculations of multigenerational α-pinene peroxy and alkoxy radical chemistry, we propose the most likely gas- and/or particle-phase formation mechanisms, which account for the observed H/D kinetic-isotope effects. These insights provide missing links that rationalize a number of observations from past studies and tie the atmospheric degradation of pinene to the production of low-volatility compounds capable of driving particle formation and growth.

1AC.5

Probing the Fate of Highly Oxygenated Molecules in Atmospheric Aerosols. XUAN ZHANG, *University of California Merced*

Highly oxygenated molecules (HOMs) originating from biogenic emissions constitute a widespread source of organic aerosols in the pristine atmosphere. Yet, the fate of HOMs upon forming new particles remain unclear. Here we present a comprehensive dataset tracking the trajectory and ultimate fate of a diverse array of HOMs in α-pinene and limonene SOA under a range of atmospheric relevant conditions. What sets this study apart from prior research is the focus on the individual behaviors of SOA-bound HOMs upon the completion of gas-phase chemistry. The observed dynamics of HOMs therefore speak directly to their particle-phase reactivity and reflect the strength of condensed-phase chemistry, if any, in altering the HOMs molecular composition. The category of HOMs is correspondingly extended to all highly oxygenated molecules that play a role in the formation and growth of SOA particles, covering the original group produced from the gas-phase autoxidation pathway, as well as those potentially resulting from a concerted gas- and particle-phase chemistry. Another highlight of this study lies in the experimental setup that mimics ambient aerosols as a mixture of sulfate, organics, and liquid water. Under such settings, individual HOMs produced through gas phase autoxidation either nucleate or condense onto existing sulfate seeds, and the impact of various environmental conditions (dark vs. photolytic and dry vs. hydrous) on the HOMs fate was explored. Temporal profiles of isomer-resolved HOMs monomers and dimers were obtained using the particle into liquid sampler coupled with an iodometry-assisted liquid chromatography mass spectrometer. These time series unveil a striking diversity in the fate of individual HOMs species, and even isomers of identical molecular exhibit distinct behaviors such as rapid decay and steady growth. The observed dynamics of SOA-bound HOMs underscore the diverse pathways that contribute to their initial formation and continually modify their composition and lifetimes in atmospheric aerosols.

1AC.6

Dependence of Reactive Oxygen Species Formation on Oxidation State of Biogenic Secondary Organic Aerosols. KASEY EDWARDS, Lena Gerritz, Manjula Canagaratna, Anita Avery, Mitchell Alton, Andrew Lambe, Sergey Nizkorodov, Manabu Shiraiwa, *University of California, Irvine*

Reactive oxygen species (ROS) play a central role in chemical aging of organic aerosols and adverse aerosol health effects upon respiratory deposition. Previous research has shown that reactive compounds such as hydroperoxides and alcohols that are present in biogenic secondary organic aerosols (SOA) form ROS. However, the influence of aging and/or SOA oxidation state on ROS yield has not been systematically investigated. In this study we quantify ROS yield in limonene SOA generated in an oxidation flow reactor (OFR) at equivalent atmospheric aging times ranging from approximately 1 to 10 days. Aqueous ROS is quantified in limonene SOA filter samples collected from the OFR using electron paramagnetic resonance (EPR) spectroscopy combined with a spin-trapping technique. We also analyze the detailed molecular composition of the SOA samples with high-resolution mass spectrometry. We observe a ~50% decrease in ROS yield when the oxygen-to-carbon ratio (O:C) of limonene SOA increases from 0.5 to 1. Similarly, the ROS yield in limonene SOA is reduced by up to 90% following 30 hrs of on-filter photoirradiation. Overall, our results suggest that the ROS yield in “fresh” limonene SOA, generated at low photochemical age, decreases due to aging-induced fragmentation and/or photolysis of species such as organic hydroperoxides that contribute to ROS formation.

1AC.7

Influence of Peroxy Radical Fate on α-Pinene Photooxidation Gas-Phase Product Distributions. LESLY FRANCO DELOYA, Erik Helstrom, Hannah Kenagy, Manjula Canagaratna, Jesse Kroll, *MIT*

Peroxy radical (RO_2) fate is known to have a major influence on gas-phase oxidation product distributions, and hence on the yields and chemistry of secondary organic aerosol (SOA) formation. However, most SOA chamber studies conducted in the past have been carried out under limited peroxy radical conditions (e.g., “high NO” or “low NO”), which are unrepresentative of most RO_2 conditions found in the atmosphere. In these chamber experiments we focus on the photooxidation of α-pinene across a range of peroxy radical reactivities (RO_2 + NO, RO_2 + HO_2, RO_2 + RO_2, and RO_2 isomerization), spanning the range of RO_2 fates most important in the global atmosphere (as determined from chemical transport modeling). Experiments were carried out in a 7.5 m^3 Teflon chamber, and an iodide chemical ionization mass spectrometer (I-CIMS) and proton transfer reaction mass spectrometer (PTR-MS) were used to measure gas-phase oxidation products. Product distributions are found to be strongly dependent on RO_2 regime, with clear changes in the formation of organonitrates, carbonyl species, and fragmentation products. Product distributions are examined as a whole via Generalized Kendrick Analysis (GKA) and hierarchical clustering, revealing broad dependencies of product formation on RO_2 chemistry. These results offer insights into how RO_2 chemistry controls the formation of key species important to SOA (e.g., functionalization products, highly oxidized molecules), thus enabling improved descriptions of the oxidation mechanisms important for SOA formation.

1AP.1

Mixing State of Refractory Black Carbon, Optical Properties and Sources of Aerosol Particles in the European Arctic Marine Boundary Layer. ARUN BABU SUJA, Thomas Müller, Mira L. Pöhlker, Heike Wex, Andreas Held, Manuela van Pinxteren, Yifan Yang, Philipp Oehlke, Sabine Lüchtrath, Holger Siebert, Theresa Mathes, Maik Merkel, Birgit Wehner, *Leibniz Institute for Tropospheric Research, Leipzig,Germany*

Aerosol particles are of critical importance to the Arctic climate system. However, there are minimal direct observations of aerosol particles over the Arctic Ocean, especially using shipborne platforms. With this in mind, we have conducted aerosol measurements aboard the German ice breaker research vessel Polarstern during the ATWAiCE (Atlantic Water pathways to the ice in the Nansen Basin and Fram Strait) cruise from June to August 2022. The aerosol characteristics were evaluated based on the influence of the airmass trajectories and divided into eight legs (L1- L8). The highest values of refractory black carbon (rBC) and light scattering were observed during L1 (up to 700N) (avg. rBC ~ 40 ng m-3, avg. σsca.525nm ~ 29 Mm-1), where the airmass trajectories were dominated by the southeastern urban continental sites. The measurement period during L4 (15th- 20th July) was influenced by a warm airmass intrusion when the ship was in the northern part of the marginal ice zone. We observed significant changes in the optical properties during this period, with major contributions of biomass burning emissions from Siberia. The rBC values have increased almost eightfold compared to the previous period in which the mass median diameter of rBC cores were >260 nm compared to ~155 nm during L1. Further, the observed coating thickness of rBC was lower (median ~ 11 nm) than the observations from other periods. The lowest values of scattering/absorption in the central Arctic were observed during 23rd - 30th July when the ship was mostly traversing through the densely packed ice associated with northeasterly air masses traversing the Arctic Ocean. It was also noted that the aerosol concentrations were relatively higher during 01st - 03rd August, which was associated with more air masses being transported through the oceanic sectors from the south, including the North Sea and Norwegian Sea when the ship crossed the outer edge of the marginal ice zone.

1AP.2

Darwin's Dust and the Search for Signs of Past 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 and collected samples of dust deposited on board the Beagle. He sent the samples to Professor Christian Ehrenberg, who found that “*this dust consists in great part of infusoria* [diatoms] *with siliceous shields*.” Darwin concluded from the samples and meteorological conditions that the dust originated from ancient African freshwater lakes more than 600 km away. Therefore, Darwin had remotely detected signs of past life in Africa.

The current search for signs of past life on Mars is focused on using a rover to obtain and examine local soil samples from the delta of an ancient river, where life may have occurred. Currently, soil samples are being stored, for retrieval during the planned Mars Sample Return (MSR) mission, for further examination on Earth. However, very recently it has become clear that MSR may be delayed until 2040 with a greatly increased budget (≈$10G). Therefore, NASA is searching for alternative MSR concepts, and alternative ways of looking for signs of past life on Mars may also be of interest.

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 past life on Mars, based on the examination of mineral dust. Mars aerosols are completely dominated by mineral dust continuously cycled, that is entrained and deposited, all over Mars. Therefore, it would be possible to obtain and examine mineral dust from the entire Martian surface at a single surface sampling location. Such examination of deposited mineral dust for signs of past life could utilize optical and/or electron microscopy without need for MSR.

1AP.3

Correlation of Optical Properties with Particle Size, Morphology, and Crystal Structure for Multiple Sources of Submicron Titanium Dioxide Particles. SCHUYLER LOCKWOOD, Zezhen Cheng, Tanya Myers, Timothy Johnson, Alla Zelenyuk, *Pacific Northwest National Laboratory*

Titanium dioxide ($TiO_{2)}$ particulates are known to exhibit different visible and infrared optical properties vs. the bulk material. Such properties are further known to depend strongly on particle size. For example, ultrafine particles (<100 nm primary particle diameter) of the rutile polymorph are used in sunscreen and appear transparent, while larger particles (200-300 nm) are used as pigments or reflective coatings, appearing bright white. Larger particles are also of interest for geoengineering (cloud brightening) due to (1) the high refractive index of TiO_2 across much of the UV, visible, and infrared wavelength regions and (2) the large scattering cross sections of TiO_2 nanoparticles, particularly at UV wavelengths. TiO_2 also exhibits high photocatalytic activity in reactions involving many organic materials (and even water), potentially complicating its effects on cloud/aerosol chemistry in these applications. In this study, we compare the optical properties, sizes and morphologies of TiO_2 particles from several sources with nominally different primary particle sizes and various mixtures of crystal polymorphs using a combination of methods including single particle mass spectrometry, optical spectroscopy, and several submicron aerosol characterization instruments. Some of the methods are used to investigate structural changes in different sources of TiO_2 particles upon coating of the particles with water or organic liquids.

1AP.4

Optical Properties of Light Absorbing Aerosol Particles at Elevated Relative Humidity. GWEN RACHEL LAWSON, Simon Xi Chen, Justin Langridge, Kate Szpek, Michael Cotterell, *University of Bristol*

Interactions of aerosols with light affect the overall radiative forcing of the Earth's climate. Despite this importance, they remain one of the largest uncertainties in climate models, limiting future improvements as illustrated by the IPCC report (2021). The absorption of light by atmospheric aerosols and the role of volatile components are not well understood. Photoacoustic spectroscopy (PAS) has been shown to provide accurate absorption measurements for sub-micron, dry aerosol particles devoid of any volatile components (Langridge et al., 2013). PAS uses a periodically modulated laser to irradiate an aerosol sample. Light absorbing aerosols are heated by the laser and transfer their heat to the surrounding bath gas, which undergoes periods of adiabatic expansion and contraction, generating acoustic waves. The amplitude of the acoustic wave is related to the absorption coefficient through calibration. PAS relies on efficient heat flux from the particles to the bath gas to generate this acoustic wave. When there is water or other volatile compounds present, the measured absorption is low biased for sub-micron particles since the additional heat flux pathway via evaporation has a lower conversion efficiency than the sensible heat flux. Extending the current PAS technique to facilitate measurements of absorbing aerosols at high relative humidity represents a key improvement to allow measurements of aerosol absorption under atmospherically relevant conditions. We use cavity ring down spectroscopy (CRDS) to measure the extinction coefficients of hydrated aerosol particles, at a range of elevated relative humidities, to characterize the hygroscopic growth. We then explore the potential to use the phase shift, the difference in phase between the waveforms of the periodically modulated laser and the generated sound wave, to correct the measured absorption for the presence of water at elevated relative humidity. This would allow PAS to measure aerosol absorption outside of the current limitation of dry conditions.

1AP.5

A New Mixing Rule for Imaginary Refractive Indices of Aerosols or Colloids in the Rayleigh Regime. JUSTIN MAUGHAN, Hans Moosmüller, Prakash Gautam, Christopher M. Sorensen, *Pratt Community College*

A new Rayleigh mixing rule that relates the effective imaginary part of the refractive index of a composite medium to the complex refractive index of the Rayleigh particles within a non-absorbing medium is derived using Rayleigh scattering theory. The new Rayleigh mixing rule is compared with widely used mixing rules (i.e., volume, Maxwell Garnett, and Bruggeman mixing rules) and we show that in the small volume fraction regime both the Maxwell Garnet and Bruggeman mixing rules agree with the Rayleigh mixing rule. The Multiple Sphere T-Matrix (MSTM) code by Mackowski is used to calculate the total extinction, absorption, and scattering cross sections for a spherical non-absorbing medium with absorbing Rayleigh particles inclusions randomly imbedded within the medium. The MSTM results are compared to that of Mie theory calculations using the effective refractive indices given by the Rayleigh, volume, Maxwell Garnett, and Bruggeman mixing rules. Comparison of the MSTM and Mie results for volume fractions of 0.01, 0.03, 0.1, and 0.3 show that for all volume fractions except 0.3, and all mixing rules except the volume mixing rule, there was good agreement. Fractional differences were within approximately 10% or less when comparing mixing rule results to the actual MSTM results for relative refractive indices of the Rayleigh inclusions smaller than 2.0+i.

1AP.6

Ideal Mixing of the Complex Refractive Index for Organic Internally Mixed Light Absorbing Aerosol Particles. SIMON XI CHEN, Gwen Rachel Lawson, Justin Langridge, Kate Szpek, James Allan, Michael Cotterell, *University of Bristol*

To predict variations in the complex refractive index of aerosol particles, densities for dry internally mixed particles are needed in physically based models and often are predicted by models assuming ideal mixing. Yet, Vokes et al., (2022) have reported substantial deviations in measured effective densities from expectations of an ideal mixing model for two-component organic-inorganic mixtures, which might impact the aerosol particle optical properties.

Here we used an Aerodynamic Aerosol Classifier (AAC) to classify particles by their aerodynamic diameter in the range 100 - 400 nm. Combined with a Scanning Mobility Particle Sizer (SMPS) for quantifying the particle mobility diameter distribution, we determined the particle densities for two-component nonreactive light absorbing organic particles containing nigrosin and sucrose. Concurrently, we used cavity ring-down spectroscopy (CRDS) and photoacoustic spectroscopy (PAS) to measure the ensemble-mean extinction and absorption cross sections for the aerodynamically classified particles, from which we retrieved the complex refractive indices (RI) for the nigrosin-sucrose mixed particles at optical wavelengths of 405 and 658 nm. Both measured densities and the real (n) and imaginary (k) components of nigrosin-sucrose mixed particles were in close agreement with ideal mixing predictions as well as those that have an underlying physical basis, in stark contrast to results for inorganic-organic mixed particles.

In this contribution, we also assess the accuracy of complex RI retrievals from both the extinction and absorption, as well as from the extinction only. Comparisons of n and k from the two retrieval approaches show small differences, contrary to previous assessments that had used electrical mobility selection to control the particle size.

1AP.7

Radiative Cooling in New York/New Jersey Metropolitan Areas by Wildfire Particulate Matter. GEORGIOS A. KELESIDIS, Constantinos Moularas, Hooman Parhizkar, Leonardo Calderón, Irini Tsiodra, Nikolaos Mihalopoulos, Ilias Kavouras, Panos G. Georgopoulos, Jose Guillermo Cedeno Laurent, Philip Demokritou, *Rutgers, The State University of New Jersey*

Wildfire particulate matter (WFPM) from Canadian forest fires significantly impacted air quality in the northeastern United States during the summer of 2023, raising concerns about potential public health implications. Here, we used state-of-the-art real time and time integrated instrumentation to characterize the physicochemical properties and radiative effects of WFPM reaching the highly populated metropolitan areas of New Jersey/New York during this extreme wildfire incident. The major finding of this study is the light absorption and scattering of the WFPM measured during the peak of the event that were three and two times higher than those obtained for normal traffic-related particulate matter sampled five days later, respectively. The direct radiative forcing, *RF*, of WFPM during the peak of the event ranged from -9 to -18.7 W/m^2, corresponding to a potential air temperature reduction of 2.3-4.7 K. Such negative *RF* in densely populated megacities may limit natural ventilation, increase the residence time of WFPM and other background air pollutants, exacerbating public health risks. This study highlights the importance of radiative effects from WFPM in densely populated areas and their potential implications for air quality and public health, in line with emerging epidemiological evidence in the area affected by the wildfire event.

1CT.1 – INVITED

Influence of Gas Phase Compounds on CCN Activity Observed during the Eastern Pacific Cloud Aerosol Precipitation Experiment. MARKUS PETTERS, Elavarasi Ravichandran, Sanghee Han, Abigail Williams, Jeramy Dedrick, Christian Pelayo, Nattamon (Jeep) Maneenoi, Lauren Robinson, Rachel Chang, Michael Wheeler, Jeremy Wentzell, John Liggio, Lynn M. Russell, *University of California, Riverside*

One of the less-well understood influences on the CCN activity of particles, particularly under ambient conditions, is the role of the gas phase in modifying activation supersaturation of a particle. Co-condensation of gas-phase species can dissolve into the growing droplet adding to the solute mass. Organic trace gasses can adsorb to the water/air interface and modify the surface tension of the drop. These effects may alter the activation supersaturation relative to that attributable to dry particle composition alone. Here we show observational evidence of the influence of gas-phase compounds on the activation supersaturation obtained during the Eastern Pacific Cloud Aerosol Precipitation Experiment (EPCAPE) campaign. The mobility size distribution and size-resolved hygroscopicity parameter were measured by interfacing a scanning mobility particle spectrometer with a condensation particle counter and a continuous flow CCN counter sampling between 0.2 and 1% supersaturation. Optionally, particles exiting the differential mobility analyzer column were denuded prior to entering the CCN counter. The denuder removed volatile organic compounds from the gas-phase. Cloud droplet residuals were sampled behind a counterflow virtual impactor inlet. In parallel, the particle size distribution D > ~0.15 µm was measured using a portable optical particle spectrometer. The hygroscopicity parameter κ typically varied between 0.2 and 0.4 before, during and after the cloud event for all supersaturations except s = 0.2%, which often showed much higher κ values. These results are broadly consistent with hygroscopicity parameters measured at the Scripps Pier using a humidified tandem differential mobility analyzer. Inclusion of the denuder perturbed the derived κ by up to 50%. The effect is intermittent but was observed throughout the study period between Feb and August 2024. When present, the effect of denuding is often, but not always to render the particles less CCN active. These data demonstrate a surprisingly strong and not yet fully understood influence of the gas phase on CCN activity.

1CT.2

Contributions of Organic Factors to Particle Hygroscopicity and Cloud Condensation Nuclei during the Eastern Pacific Cloud Aerosol Precipitation Experiment (EPCAPE). VERONICA BERTA, Sanghee Han, Abigail Williams, Jeramy Dedrick, Christian Pelayo, Lynn M. Russell, Elavarasi Ravichandran, Markus Petters, Ryan Farley, Allison Aiken, Manvendra Dubey, *Scripps/UCSD*

Uncertainties in cloud properties associated with cloud condensation nuclei (CCN) sources remain an important issue for climate modeling of coastal areas due to the mixture of polluted urban and relatively pristine marine air masses that result in diverse aerosol compositions. During the Eastern Pacific Cloud Aerosol Precipitation Experiment (EPCAPE) in La Jolla, California, ambient High Resolution Time-of-Flight Aerosol Mass Spectrometry (HR-ToF-AMS) measurements at Mt. Soledad provided insight into the chemical composition of non-refractory components. Organic mass constituted 55% of the total measured mass on average, illustrating the importance of organic hygroscopicity for CCN activity. Positive matrix factorization (PMF) analysis was used to apportion different sources of these organics, resolving five independent factors that were characterized by (i) several hydrocarbon peaks, (ii) organic sulfate peaks, (iii) organic nitrogen peaks, (iv) high m/z 44 contribution, and (v) a lower m/z 44 contribution. Their ratios of atomic oxygen to atomic carbon (O/C), a metric of their degree of oxidation, ranged from 0.32-1.46. Hygroscopicity was estimated for each of the five factors using different methods; volume-weighted mass concentrations for each factor were then averaged to estimate organic hygroscopicity (κ_{org}). Compared to using a constant κ_{org} of 0.1, varying κ_{org} based on O/C to determine hygroscopicity derived from AMS composition (κ_{AMS}) resulted in stronger correlations between κ_{AMS} and hygroscopicity measured by size-resolved CCN measurements (κ_{CCN}) at all supersaturations (0.2-1.0%). κ_{AMS} estimated from O/C derived from all factors resulted in the highest correlation of R = 0.69 at 0.2% supersaturation with κ_{CCN}. These correlations were weaker at higher supersaturations but were improved by estimating κ_{org} from O/C of PMF factors associated with Aitken mode aerosol mass concentrations. Among the five resolved PMF factors, only the factor containing organic sulfate peaks correlated with elevated κ_{org} (R = 0.27), κ_{AMS} (R = 0.41), and with κ_{CCN} at 0.2% supersaturation (R = 0.47). This factor's mass concentrations were highest during late spring and early summer, peaking in May when it comprised nearly a third of organic mass. These results provide characterization of organic aerosols and their impact on aerosol-cloud interactions in coastal environments.

1CT.3

Marine and Anthropogenic Effects on Ultrafine Aerosol Composition during the Eastern Pacific Cloud Aerosol Precipitation Experiment. ANNA KAPP, Kristen Cramer, Nhu-Naomi Nguyen, James Smith, *Univeristy of California, Irvine*

Oceans produce primary sea spray aerosol in addition to contributing to the production of gases that oxidize to form secondary marine aerosol. Coastal cities are influenced by both marine and anthropogenic aerosol precursors. The extent to which marine influence is present in aerosol composition in coastal cities and how marine aerosol precursors interact with anthropogenic compounds are poorly understood. To address this, the Eastern Pacific Cloud Aerosol Precipitation Experiment-Ultrafine Particle Properties (EPCAPE-UPP) campaign took place from April 15th to June 15th, 2023, in La Jolla, California. La Jolla is subject to heavily polluted winds from Los Angeles, but it is also influenced by “clean marine” background winds from the Pacific Ocean, making it the perfect place to examine particles formation from marine and urban emissions.

We report measurements from a hygroscopicity tandem differential mobility analyzer (HTDMA). Measured growth factors at 85% RH ranged from 1.1 and 1.3, suggesting that particles at the site are mostly made up of a mixture of organic compounds and sulfate. Volatility tandem differential mobility analyzer (VTDMA) measurements found that most ultrafine particles volatilized between 80°C and 160°C which rules out a major contribution from NaCl to ultrafine particle composition and is consistent with HTDMA-derived growth factors. We also measured size-resolved particle composition using thermal desorption chemical ionization mass spectrometry (TDCIMS). Those measurements show that ultrafine particles contained some NaCl at the beginning of the campaign, indicating that the first few weeks of were a period of particular influence by marine processes in La Jolla. Other compounds, including amines and multifunctional organics, were detected in particles and point to specific processes responsible for ultrafine particle growth.

1CT.4

Aerosol and Trace Gas Composition and Source Apportionment in Two Coastal Cities: Houston, TX and San Diego, CA. MARIA ZAWADOWICZ, Mirtha Salatti, Chongai Kuang, Ashish Singh, Janek Uin, Ogochukwu Enekwizu, Arthur J. Sedlacek, Rebecca Trojanowski, Olga Mayol-Bracero, *Brookhaven National Laboratory*

Coastal urban environments are a complex confluence of natural terrestrial and marine ecosystems and anthropogenic activities. At the same time, the coasts are where the greatest number of people, infrastructure, and ecological resources are in danger from global climate change. In this presentation, we will discuss the results from two recent coastal urban campaigns: the 2021–2022 TRacking Aerosol Convection interactions ExpeRiment (TRACER) in Houston, TX and the 2023–2024 Eastern Pacific Cloud Aerosol Precipitation Experiment (EPCAPE) in San Diego, CA. Both of these campaigns used the aerosol instruments deployed as a part of the first Atmospheric Radiation Measurement (ARM) Mobile Facility (AMF1), which include in-situ measurements of aerosol and trace gas chemistry, aerosol size distributions, optical properties and hygroscopicity, and atmospheric state and meteorology. We use the extensive aerosol characterization measurements together with the NOAA Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model to source apportion the aerosol measured in Houston and San Diego. Using statistical techniques, including positive matrix factorization (PMF), hierarchical clustering and self-organizing maps (SOM), we sort the observed aerosol properties into regimes, which allow the description of comprehensive aerosol climatology in the two different coastal environments. We then compare the resulting climatologies and interpret them in the context of the local and regional meteorology.

1CT.5

Influence of Urban and Marine Aerosol on Coastal Cloud Processing at Mt. Soledad in Southern California during EPCAPE.

RYAN FARLEY, Kyle Gorkowski, James E. Lee, Katherine Benedict, Abu Sayeed Md Shawon, Nevil Franco, Veronica Berta, Lynn M. Russell, Manvendra Dubey, Allison Aiken, *Los Alamos National Laboratory*

Anthropogenic aerosol influence marine cloud properties in many coastal regions, but their impacts and interactions remain poorly understood due to their complexity and difficulty in observing these processes in situ. Cloud interactions are a significant but highly uncertain removal process for aerosol with the removal rates depending on aerosol composition. Additionally, the chemical transformations of material within cloud droplets can significantly alter the composition, cloud and ice activation, and optical properties of the aerosol following droplet evaporation. In this work, measurements of aerosol chemical, physical, optical, and hygroscopic properties were collected at the Mt. Soledad site in La Jolla, CA (elevation 250m, 2 km from shore) as part of the Eastern Pacific Cloud Aerosol Precipitation Experiment Partitioning Thrust by Los Alamos National Laboratory (EPCAPE-PT-LANL) from October to December 2023. A ground based counterflow virtual impactor was utilized to directly measure the properties of cloud droplet residuals and compare with aerosols measured immediately adjacent to cloud periods. Two in-cloud periods are presented with different airmass trajectories, one from the north and one from the south. A comparison of the high-resolution aerosol mass spectrometer measurements of droplet residuals and out of cloud particles highlight the role of cloud processing on altering aerosol composition. Specifically, inorganic nitrate fraction increased 2-fold and chloride fraction increased 3-fold relative to the interstitial (non-activated) aerosol. Differences in VOC concentrations measured by Proton Transfer Mass spectrometry (PTR-MS) during the cloud events and their role in SOA formation will also be discussed. Source apportionment analysis revealed that this site is impacted by both marine sources and transported pollutants from local and regional urban centers, providing an ideal opportunity to characterize cloud processing from the East Pacific under varying conditions at the coast. These results help constrain the role of different aerosol sources on cloud formation and properties.

1CT.6

Black Carbon Aerosol Characteristics and Aerosol-Cloud Interactions near the Coast of Southern California.

DONGLI WANG, Bradley Ries, Minghao Han, Alexander B. MacDonald, Mason Leandro, Sierra Bollinger, Lisa Welp-Smith, Roya Bahreini, Anthony Bucholtz, Patrick Chuang, Mikael Witte, Don Collins, Andrew Metcalf, *Clemson University*

This study characterizes the nature of black carbon (BC) aerosols over the northeastern Pacific Ocean and investigates the interactions between BC particles and the marine atmosphere, including the persistent stratocumulus. The data are from a suite of aerosol and cloud instruments onboard the Navy Twin Otter aircraft, which conducted 21 flight observations near San Diego, CA in June 2023 as part of the SCILLA field campaign in coordination with the EPCAPE campaign. A Counter-flow Virtual Impactor (CVI) inlet was used to sample cloud residuals and an isokinetic inlet was used to sample cloud-free particles. A Scanning Electrical Mobility Spectrometer (SEMS) was used to measure the total submicron aerosol size distributions. A Single Particle Soot Photometer (SP2) was employed as the primary measurement of BC aerosol, while a mini Aerosol Mass Spectrometer (mAMS) measured non-refractory aerosol composition. Various wing-mounted cloud probes characterized the cloud droplet number concentrations and size distributions.

In this presentation, we examine two flights focused on the outflow region of Los Angeles with limited cloud cover and two flights near San Clemente Island with persistent stratocumulus. The mass concentration, size distributions, and mixing state of BC aerosols in cloud droplet residuals and cloud-free air are compared to analyze the interactions between BC aerosol and cloud droplets. These aerosol properties are also used to understand the influence that Los Angeles outflow has on the regional cloud cover. Detailed characterization of aerosols and clouds will help to understand the connection between BC aerosol and cloud properties to evaluate their impact on the marine environment.

1CT.7

Twelve Months of Aerosol and Cloud Microphysics during the Eastern Pacific Cloud Aerosol Precipitation Experiment (EPCAPE). LYNN M. RUSSELL, Abigail Williams, Jeramy Dedrick, Veronica Berta, Christian Pelayo, Nattamon (Jeep) Maneenoi, Sanghee Han, Atsushi Osawa, Louise Tibia, Karoline Braga, Elavarasi Ravichandran, Markus Petters, Lauren Robinson, Rachel Chang, Michael Wheeler, Jeremy Wentzell, John Liggio, Israel Silber, 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. The Eastern Pacific Cloud Aerosol Precipitation Experiment (EPCAPE) at La Jolla sampled air masses at the Scripps Pier and the Mt. Soledad that were usually more than 90% northwesterly, roughly following the southern California coast for the prior two days bring a mixture urban and marine emissions. DOE ARM cloud, aerosol, and precipitation measurements at the Scripps Pier from February 2023 to February 2024 combined with a multi-institution, international collaboration at Mt. Soledad to characterize aerosol particle size distributions at both sites and cloud properties. Twelve months of sampling from an isokinetic aerosol inlet in clear air and more than 800 hr of measurements behind a counterflow virtual impactor in cloud provide a detailed climatology of the activated and unactivated phases associated with cloud processing and microphysics. This overview summarizes the variability in the aerosol size distributions and properties at both sites associated with clear and cloudy conditions. In-cloud size distributions show clear evidence of Hoppel minima, while clear-air submicron distributions were bimodal or only single, broad lognormal modes with concentrations typically <3000 cm^{-3}. Cloud condensation nuclei concentrations at 0.2% supersaturation typically ranged between 200 and 800 cm^{-3}. Low cloud liquid water content (<0.3 g m^{-3}) and small mean volume diameters (5-30 µm) reveal many hygroscopic particles that constitute only part of the ambient submicron mass concentration. Non-refractory submicron mass concentration was 1-4 µg m^{-3}, usually consisting of more than half non-refractory organic components with sulfate then nitrate and ammonium making up most of the remaining submicron non-refractory mass concentration. Sea salt and trace metals contributed less than 20% of submicron mass concentration and refractory black carbon accounted for <0.1 µg m^{-3}. Hygroscopicity parameters derived from size-resolved cloud condensation nuclei show particles <0.1 µm diameter being less hygroscopic with higher organic fraction than larger ones. Rain events with more than 0.4 mm/hr exceeded 30 min duration on 29 days and provided episodic particle sinks, with local vehicle sources contributing intermittent emissions at both sites. Together these results show cloud effects in a variety of aerosol conditions, providing important constraints for modeling aerosol indirect effects.

1IA.1

Comparing Human Emissions of Volatile Organic Compounds during University Lectures and Final Exams. SABRINA WESTGATE, Yutong Liang, Nga Lee Ng, *Georgia Institute of Technology*

Indoor air quality, including exposure to volatile organic compounds (VOCs), can significantly impact our health, cognition, and well-being. Indoors, particularly in university classrooms, our exposure to VOCs is dominated by emissions from our clothing, breath, and skin. Previous studies have indicated that human VOC emission profiles vary depending on demographic characteristics, the activity being undertaken, and potentially even mental state. In this study, we conducted indoor measurements during a series of regular lectures and during a series of final university exams on the Georgia Institute of Technology campus, to investigate if human VOC emissions and overall indoor air quality are impacted by high psychological stress conditions. Online VOC measurements were made with a Vocus Proton-Transfer-Reactor Mass-Spectrometer (Vocus PTR, Aerodyne), and a suite of gas phase instrumentation measured O_3, CO_2, and NO_x, both inside the classroom and in the ventilation duct supplying air to the room. Preliminary results indicate that CO_2 and primarily human emitted VOC levels were elevated during the exam periods compared to the lectures, and that there was high variability in the types of VOCs emitted by different student cohorts. In general, it was observed that the fraction of acetone (a VOC emitted in breath) in total VOCs increased during the exams as compared to the respective lectures, and the fraction of cyclic siloxanes (often associated with personal care products) decreased during the exams. Results from this study provide new insights into human emissions of VOCs during a high stress situation like taking an exam, and implications of this research could impact recommendations for examination room usage guidelines.

1IA.2

Influence of Human Activities and Occupancy on the Emission of Indoor Particles from Respiratory and Non-respiratory Sources.

P. S. GANESH SUBRAMANIAN, Joseph V. Puthussery, Yuqing Mao, Sudheer Salana, Thanh H. Nguyen, Ty Newell, Vishal Verma, *University of Illinois Urbana-Champaign*

Airborne transmission is an important pathway leading to the spread of infectious diseases, particularly in indoor settings. In this study, we examined the relationship between human activities and emission characteristics of CO_2 and particles (0.3 – 10 µm) in a clean-environmental chamber, a café, and a music club. We measured the CO_2 and particle emission rates (CER and PER) across three human activities, in masked (N-95) vs. unmasked scenarios, as well as normal vs. cleanroom clothing (CRC) scenarios in a chamber to estimate the relative contribution of respiratory and non-respiratory aerosol emissions from humans. Particle number concentration (PNC) and CO_2 were measured alongside human occupancy in two real-world environments (i.e., café and club) to quantify the dependence of CO_2 and PNC on human occupancy. Results from the unmasked experiments revealed that both CER and PER were highest during exercise activity, but the difference in CER or PER between passive activities (sitting vs. reading aloud) was not statistically significant. Masking led to significant reduction (~ 10%, $p<0.05$) in CER across all activities, but led to a reduction in PER only during exercise (~ 11%, $p<0.05$), indicating that respiratory sources constitute a tiny fraction of the total particle emissions during passive activities. However, donning CRC reduced the PER by over 55% for all activities, demonstrating that clothing and skin-shedding constitute a dominant fraction of particle emissions from humans. Results from the real-world environments revealed that both CO_2 and PNC were mostly driven by human occupancy ($R > 0.60$, $p<0.05$), albeit with effect modifiers such as filtration, cooking activities, etc. Collectively, these results demonstrate that non-respiratory emissions (e.g., clothing and skin-shedding) from humans outnumber respiratory emissions in indoor environments, emphasizing the need to better quantify the contribution and evaluate the potential role of non-respiratory emissions from humans in the airborne transmission of infectious diseases.

1IA.3

Assessing the Influence of Hydration Levels on Respiratory Aerosol Production.

Mahender Singh Rawat, Dinushani Senarathna, Byron D. Erath, Sumona Mondal, Sarah K. Sirsat, ANDREA FERRO, *Clarkson University*

Reported emission rates of respiratory aerosols from speaking, shouting, singing, coughing, and breathing vary widely in the literature. Several factors, such as loudness, frequency, and age, have been shown to affect respiratory particle emissions rates. However, these factors alone are not sufficient to predict emission rates. Previous work has shown dehydration reduces saliva and respiratory tract lining fluid production and changes the rheology of these fluids. Hence, it is hypothesized that hydration levels influence respiratory aerosol production. This is evaluated by measuring respiratory aerosol emissions from participants in both well-hydrated and dehydrated conditions. Participants were asked to phonate into a funnel connected to an aerodynamic particle sizer (APS) to determine the aerosol emission rate and size distribution. To measure the expiratory flow rate, participants were asked to phonate the same vocal sequences into a Vyntus Hans Rudolf mask kit connected to a spirometer (iWorx TA Model 220). The participants performed several vocal exercises, in random order, including the open vowel /a/, forced breathing, and running speech. The preliminary results showed that the hydrated participants emitted 35% more particles by number than the dehydrated participants during the vocal exercises. Our initial findings are consistent with the hypothesis that participants who are well-hydrated tend to have higher aerosol emission rates compared to when they are dehydrated.

1IA.4

The Impacts of Dust Events on Indoor Air Quality. KARIN ARDON-DRYER, *Department of Geosciences, Texas Tech University*

Indoor environments contribute to health risks based on air quality levels. Indoor particulate matter (PM) is produced due to indoor activity including cooking, heating, smoking, and beauty products. In some cases, outdoor pollution can influence the PM concentration in indoor environments. Arid or semi-arid areas' dust events are a major contributor to particulate matter levels in indoor environments. In this study, measurements of indoor and outdoor PM concentrations and particle size distribution were performed in a private home in Lubbock, Texas. Two Grimm 11-D and two TSI OPS3330 were used, and each pair (Grimm and OPS) was placed in different locations of the house. Two units collected outdoor particles as part of AEROS-HOME and two other units were placed in the living room. Comparison between indoor and outdoor particle concentrations and size distribution will show the impact of dust events on indoor environments.

1IA.5

Influence of Sage Burning on Indoor Air Quality: A Case Study Using Low-Cost Sensors. DANIEL B. CURTIS, Genna Munoz, *California State University, Fullerton*

Sage burning, also called smudging, is a practice of smoldering White sage and other plants indoors in order to ‘spiritually cleanse’ the space. Although sage burning is historically associated with indigenous groups in the Southwestern United States and Northern Mexico, the practice has become popular with other groups, especially through social media. Although many users assume that sage burning cleans the indoor air, and some studies have found that bacterial populations are reduced by the practice, biomass burning is known to emit various harmful products and indoor exposure to the particles may cause various health effects in humans.

The purpose of this study was to perform indoor sage burning and quantify particulate emissions and chemical properties of emitted particulate matter. White sage was smoldered in a private residence in Southern California and $PM_{2.5}$ concentrations were quantified using low-cost sensors, personal air samplers, and portable aethalometers. Preliminary results indicate that particle concentrations approached roughly 100 µg m^{-3}, approximately 10 times the EPA annual standard for $PM_{2.5}$. Particle concentrations then decayed exponentially, persisting over roughly 12 hours following sage burning. Planned studies will quantify black carbon and brown carbon concentrations and chemical composition of the particles. In addition, low-cost particulate sensors will be inter-compared to determine efficacy in quantifying emissions from sage burning.

1IA.6

Indoor SOA from OH Radical Chemistry Initiated by Chlorine. Pearl Abue, KATARINA KONON, Lea El Khoury, Mrinali Modi, Lea Hildebrandt Ruiz, *University of Texas at Austin*

Hydroxyl radical (OH) chemistry is a dominant source of secondary organic aerosol (SOA) in outdoor environments. Indoors, OH chemistry is thought to occur primarily when outdoor lighting penetrates indoors. Chlorine radical (Cl) chemistry can be initiated under indoor lighting, as chlorine gas (Cl_2) and other Cl precursors can be photolyzed by LED and fluorescent lights. In the presence of NOx, Cl radical chemistry results in the formation of OH and resulting OH radical chemistry indoors. We conducted environmental chamber experiments on the Cl-initiated oxidation of limonene. We show based on data and chamber modeling results that, in the presence of NOx, concentrations of OH exceed concentrations of Cl by approximately one order of magnitude, and that most of the limonene is oxidized by OH, not Cl. Consistent with this, most observed gas and particle-phase products (including $C_{10}H_{17}NO_4$ and $C_9H_{15}NO_5$, for example) are from OH oxidation of limonene. Thus, OH chemistry can substantially influence indoor SOA loadings in the presence of chlorine (from e.g. cleaning) and NOx (from e.g. cooking).

1IA.7

Aerosol Formation Initiated by Oxidation of Limonene: A Comparison of Oxidant Chemistry. ANITA AVERY, Mitchell Alton, Manjula Canagaratna, Andrew Lambe, *Aerodyne Research, Inc.*

Reactions of volatile organic compounds (VOCs) with various radicals generates oxygenated VOCS (OVOCs) and secondary organic aerosol (SOA) species. However, depending on outdoor sources and human activities, a different oxidant will dominate the initial reaction and resulting products. Limonene is released indoors both in bursts as part of fragrances or cleaning products and at lower levels from outdoor infiltration. Here we compare chlorine radicals (Cl) and hydroxyl radicals (OH) that are emitted from bleach cleaning activities, and ozone (O_3) oxidation of limonene, using an oxidation flow reactor (OFR). The yield and chemical composition of OVOCs/SOA generated from these reactions were characterized with several online measurements, including an aerosol mass spectrometer (AMS), an extractive electrospray chemical ionization mass spectrometer (EESI-CIMS), and scanning mobility particle sizer (SMPS). We observe that in addition to Cl being highly efficient at oxidizing organic molecules, it also promotes the formation of condensable vapors compared to OH. Low-volatility limonene oxidation products such as $C_{10}H_{18}O_5$ were detected by the EESI to provide such molecular characterization of products to compliment the bulk organic aerosol measured by the AMS. Resulting aerosols were small, with a mode number size distribution generally below 50 nm. Maximum SOA yields were highest with limonene/Cl, followed by OH and O3. This work can help inform aerosol exposure during common indoor activities.

1IM.1

Frequency-Resolved Single-Particle Photothermal Interferometry.

FELIX STOLLBERGER, Michael Gleichweit, Ruth Signorell, Alexander Bergmann, *Graz University of Technology*

Photoacoustic spectroscopy (PAS) is a well-established technique to probe optical or physicochemical properties of ambient aerosols and single particles. Theoretic studies have shown that the frequency-dependency of the photoacoustic signal contains information about evaporation-condensation and thermal equilibrium effects. This dependency could be exploited to measure heat capacity, absorption cross-section, or related heat-transport phenomena of aerosols.

Such measurements have not been possible due to the restrictions imposed by acoustic resonators necessary for PAS. The closely related photothermal interferometry (PTI) is not subject to such constraints, as the employed optical resonator allows free tuning of the modulation frequency. However, this property has only been used to optimize the SNR of the photothermal signal and not to investigate the frequency dependency of the photothermal effect systematically. With this study, we present a novel experimental method for performing frequency-resolved PTI on single aerosol particles.

The experimental setup features counter-propagating optical tweezers to trap single, micrometer-sized tetraethylene glycol (TEG) droplets within the cavity of a Fabry-Pérot interferometer. The particles are excited by a sinusoidally modulated infrared laser aligned with one of the trapping beams. While the particle is evaporating, the modulation frequency of the infrared laser is periodically swept in a range of 10 Hz to 100 kHz. Lock-in detection is used to record the photothermal amplitude (PTA) and phase (PTP), which are correlated with the particle radius obtained from static light scattering after the experiment.

Our experimental results show a clear size and frequency dependence of the PTA, with a decrease proportional to $1/f^2$ for modulation frequencies above 2 kHz. This contradicts the previously modelled and measured 1/f behavior of ensemble PTI measurements. The PTP exhibits the theoretically predicted size and frequency dependency and saturates with strong fluctuations above 5 kHz.

Overall, we prove the applicability of frequency-resolved PTI and present the first experimental data from single particles in the Knudsen transition regime. The proposed method could be used to measure the heat capacity or absorption cross-sections on single-particle levels by fitting the data with a theoretical model.

1IM.2

Broadband Light Scattering and Cavity Ring-Down Spectroscopy Measurements on Single Light-Absorbing Aerosol Particles.

AIDAN RAFFERTY, Andrew J. Orr-Ewing, Jonathan P. Reid, Michael Cotterell, *University of Oxford*

Aerosol in the atmosphere has a profound effect on the Earth's energy budget and climate. Current climate models have a large uncertainty associated with the aerosol contribution. In part, this is due to a poor understanding of the physical and chemical properties of these aerosol particles. Of particular importance is the complex refractive index of aerosol, $m = n + ik$. The relative values of n and k determine the fraction of light scattered and absorbed by an aerosol particle. This in turn determines whether aerosol has a local cooling or heating effect. Values of k for absorbing aerosol are currently poorly characterised. Thus, novel techniques for measuring k must be developed. A good way to measure aerosol properties is to make measurements on single aerosol particles to overcome ensemble averaging effects. One method that enables this approach is optical trapping. Optical trapping uses laser light to levitate an aerosol particle and enable it to be investigated over long periods of time. Most commonplace optical trapping approaches do not work for absorbing aerosol, but the use of counterpropagating hollow beams overcomes this. When focused to different points, the hollow beams create an "optical bottle" in which a single absorbing aerosol particle can be trapped. Once trapped, we investigate the particle's optical properties using a combination of two techniques: broadband light scattering (BLS) and cavity ring-down spectroscopy (CRDS). CRDS allows for highly sensitive determination of the extinction cross-section of a levitated particle. However, it cannot disentangle the various factors contributing to this on its own. By combining with BLS, we can disentangle these factors and provide wavelength-dependent information on n and k. We will provide an overview of our experimental setup, the data analysis framework, and some preliminary results.

1IM.3

Machine Learning to Identify and Define Clusters of Aerosols According to Their Optical Properties.

Zachary McQueen, Ryan Poland, GEOFFREY SMITH, *University of Georgia*

It has been shown that aerosols can be classified according to their optical properties, including absorption Ångström exponent (AÅE), scattering Ångström exponent (SÅE), single scattering albedo (SSA) and others. Typical approaches for doing so rely on presumed knowledge of how these optical properties vary for different types of particles and result in strict, sometimes subjective, criteria for separation. Here, we take a different, data-driven approach by using unsupervised machine learning methods to identify natural clusters of observations that have similar optical properties; in essence, we allow the data to define the clusters.

We show how the geographic concept of topographic prominence can be extended beyond two dimensions to identify locations of clusters that vary in density. Then, we describe the use of a density-based clustering algorithm, K-DBSCAN (Kernel-based, Density-Based Spatial Clustering of Applications with Noise; Pla-Sacristán et al., 2019), to assign samples to the clusters without assumption of cluster shapes or boundaries. We also demonstrate how the clustering model helps us to identify the optical properties that contain the most information for clustering and how the model can be adapted if only a subset of optical properties is available. Finally, we build a classification model based on the clusters found allowing new samples to be classified optically.

Reference

Pla-Sacristán, E., González-Díaz, I., Martínez-Cortés, T. & Díaz-de-María, F. Finding landmarks within settled areas using hierarchical density-based clustering and meta-data from publicly available images. Expert Syst. Appl. 123, 315–327 (2019).

1IM.4

Flow-Through Integrating Cavity Optical Absorption Spectrometer for In-Situ Cloud Water Condensed Phase Composition Measurement: Design Constraints and Initial Validation.

BENJAMIN LANG, Alexander Bergmann, *Graz University of Technology*

Accurate in-situ measurements of cloud microphysical properties are a helpful tool aiding the research of cloud radiative impact, cloud and precipitation formation, and aerosol-cloud interactions.

In mixed-phase clouds, where ice particles coexist with supercooled liquid droplets on different scales, the ratio of cloud water in the liquid phase to water in the ice phase is a parameter of special relevance, as it is important for radar, lidar and satellite retrievals, radiation transfer calculations and climate modelling. Additionally, this property crucially affects aircraft icing during flight through clouds and, therefore, is of importance to the optimization of ice detection systems and the process of representative experimental simulation of clouds in icing wind tunnels for aircraft certification.

Based on previous results demonstrating the possibility of accurately measuring the mass concentration of water droplets of different sizes in an integrating cavity absorption meter [1], we present the design considerations and first validation results of a novel optical instrument for bulk in-situ cloud water phase composition measurement. The instrument features a flow-through type integrating cavity, which largely eliminates scattering contributions to the differential, near-infrared optical absorption measurement and promises to allow direct determination of the relative fractions of both condensed phases via the different absorption coefficients. Mass proportional (linear) measurement is currently limited to particle sizes below approximately 200 µm, as determined from Mie calculations for the chosen optical wavelengths. The lower particle size and water content limit is determined by speckle noise generated in the integrating cavity. Ray tracing simulations were used to optimize the geometry of the integrating cavity based on sensitivity and signal-to-noise ratio. Aspiration efficiencies for relevant cloud particle sizes were determined by CFD simulation combined with Lagrangian particle tracking.

[1] Grafl, M., Bergmann, A., & Lang, B. (2021). Validation of Integrating Cavity Absorption Spectroscopy for Cloud and Aerosol Mass Concentration Measurement: 39th Annual Meeting of the American Association for Aerosol Research. 153.

1IM.5

Particle Sizing by Novel Scattered Light-Fluctuation Analysis.

STEPHAN GROSSE, Lukas Oeser, Lars Hillemann, J. Lienig, *ToPAS Inc., Minneapolis, USA*

Particle counting measurement methods such as the optical aerosol spectrometer can provide detailed information on the particle size distribution, but the coincidence error limits the maximum permissible number concentration to below 10E5 cm-3 [1]. At high concentrations, the measurement signal can only be analyzed photometrically (i.e. collectively). Classic photometers usually provide no particle size information.

A photometric measurement method for the simultaneous measurement of size and concentration was developed especially for absorbance arrangements [2]. It is obvious to combine the principle with an optical aerosol spectrometer. For a universal measuring device, only a scattered light arrangement can be considered, as such measuring setups are significantly more sensitive to small particles.

The work aims to develop such a method („fluctuation scattered light analysis “). Due to the random superposition of several scattered light pulses, the detector signal in the coincidence range appears at first glance to be noise. However, the signal contains information on the size and concentration of the particles. Both parameters can be extracted by a suitable regression of statistical signal parameters. Experimental investigations have shown that the accuracy of the new measurement method is better than 5% in terms of particle size and 10% in terms of number concentration. The scattered light fluctuation analysis therefore represents an opportunity to significantly extend the current range of applications for optical aerosol spectrometers.

The scope of this article will first explain in detail how the measurement method works, the measurement results will be subsequently discussed and application-specific challenges highlighted.

[1] Verein Deutscher Ingenieure, VDI 3867 Blatt 4, Berlin, Beuth Verlag GmbH, 2011.
[2] B. Wessely, Extinktionsmessung von Licht zur Charakterisierung disperser Systeme, Düsseldorf: VDI-Verl., 1999.
[3] German Patent Application DE 10 2023 111 793,9.

1IM.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 better precision and better calibration stability than a scattering-only optical particle counter. 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. Coincidence errors are no more than in a comparable scattering-only particle counter. Coincidence errors can be drastically further reduced using pulse width information only available with aerodynamic sizing.

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.

1IM.7

Method for Optimization of Experiment Design in Aerosol Size Distribution Measurement Using Multi-Angle Light Scattering.

KIRAN SEETALA, Adam Hammond, *Sandia National Laboratories*

The size distribution of an aerosol may provide vital information about its formation and evolution over time; however, time-resolved measurement of nano- and microparticle size distribution is challenging, particularly in rapidly-evolving high-speed turbulent flows such as those driven by explosives. In-situ instantaneous size measurement with repetition rates in the MHz regime is possible using the established technique known as multi-angle light scattering (MALS): by shining a laser of a specified wavelength through an aerosol, measured intensities of scattered light of specified wavelength(s) and specified scattering angles can be used to nondestructively decipher the particulate's size distribution. For this technique to be effective, it is desirable to optimize the experiment to minimize experimental 1) complexity, 2) uncertainty, and 3) physical footprint. In the past, focus has primarily been placed on finding optimal scattering angles for a fixed wavelength, or vice versa, but judicious selection of wavelength and scattering angle together presents an opportunity to improve performance, at the cost of additional optimization routines.

In this work, an optimization method has been developed combining new and established methods to minimize error by selecting the best angles for photodetectors while allowing for multiple laser wavelengths. To demonstrate its use, an experiment is designed, optimized, and completed using a reference standard aerosol with a narrow log-normal diameter distribution centered around 0.77 µm. Using the method, it was found that the best single laser wavelength to minimize error is 637 nm, with 2.3% mean diameter predicted uncertainty, and the best two-laser configuration was 445+637 nm, with 0.72% mean diameter predicted uncertainty. Through completing an experiment with available hardware using 637 nm, the mean diameter was estimated to be 0.795 µm, resulting in an error of 6.38%. These demonstrations improve confidence in the optimization method for developing a high-speed MALS-based aerosol particle sizer.

2AA.1

The Sol-Air Laboratory: An Innovative Experimental Setup for Quantifying Airborne Biocontaminant Emissions from Field Agricultural Operations. Patrick Brassard, ARACELI DALILA LARIOS MARTÍNEZ, Stéphane Godbout, Laura Mila Saavedra, Angela Trivino Arevalo, Nathalie Turgeon, Valérie Létourneau, Mahsa Baghdadi, Caroline Duchaine, *Research and Development Institute for the Agri-Environment*

Dust, gases, odors, and bioaerosols, including aerosolized human and animal pathogens and antibiotic-resistant bacteria, may be emitted in significant quantities during agricultural activities, posing potential health risks. Evaluating exposure levels to airborne biocontaminants involves measuring concentrations at specified distances from emission sources. However, to determine the emission, airflow measurement is required which is impossible to evaluate in the field.

The Sol-Air laboratory was designed and built with the aim of measuring fugitive emissions from agricultural operations such as manure spreading. It comprises a greenhouse (8 m wide x 30 m long) covered with polycarbonate functioning as a large-scale wind tunnel. Two large inlets at one end and ten fans at the other ensure controlled airflow rates and velocities. Continuous monitoring of environmental conditions, including temperature, relative humidity, and wind speed, occurs at various points within the greenhouse. A large frame filled with loam soil simulates a field, while a watering system replicates rainfall.

Spreading experiments involving various manure types were conducted in the Sol-Air Laboratory using small-scale spreading equipment. The experimental setup allowed the measurement and comparison of fugitive emissions of particulate matter, gases (CH4, N2O, CO2 and NH3), odors and bioaerosols, collected on electret filter with high-volume air samplers installed in downwind position. Total bacteria, fecal indicators, and 38 different subtypes of antibiotic-resistant genes (ARGs) were quantified by qPCR.

Overall, the median emission rates of airborne biocontaminants during spreading were the highest for poultry manure, followed by cow manure, pig slurry spread with a dribble bar and with a splash plate, respectively. This study highlights how both the type of manure and spreading equipment can influence gas, particulate matter, odor, airborne bacteria and ARGs emission rates. For upcoming studies, soil tillage and pesticide spraying trials will be conducted in the Sol-Air laboratory to measure fugitive emissions from these activities.

2AA.2

Eastern Canadian Hatching Egg Producing Farms: Carbon Dioxide, Ammonia and Airborne Dust Concentrations, and Animal and Human Health. VALÉRIE LÉTOURNEAU, Geneviève Dion, Marie-Lou Gaucher, Caroline Duchaine, *Quebec Heart and Lung Institute*

Hatching egg production takes place inside buildings equipped with mechanical ventilation systems adjusting temperature and humidity for birds' comfort. Ventilation rates need to be efficient enough to remove moisture, carbon dioxide, other noxious gases, and airborne dust. All these airborne contaminants are known to be hazardous substances for animal and human health, and, for humans, have associated permissible exposure limits (PEL) published by the Occupational Safety and Health Administration (OSHA). The present study aimed to a) measure carbon dioxide, ammonia, and airborne dust concentrations inside 10 Eastern Canadian hatching egg productions during summer, fall and winter seasons, and to b) evaluate respiratory, and ocular health of the birds. 174 samples were collected throughout the sampling campaign. Carbon dioxide and ammonia were monitored with a gas monitor GX-6000, and size distribution of the airborne dust particles with a DustTrak DRX Aerosol Monitor (model 8534). Measured concentrations of airborne total dust (90% lower than OSHA PEL), respirable dust (96% lower), and carbon dioxide (100% lower) were mostly lower than OSHA PEL for an eight-hour shift. For ammonia, 22% of the measures were above 50 ppm, the OSHA PEL for ammonia. There was significantly more airborne dust particles and ammonia in autumn than summer in the visited hatching egg productions (no difference between autumn and winter). Carbon dioxide concentrations were significantly higher in autumn than summer and higher in winter than autumn. By opposition to airborne total dust concentrations, the amount of ammonia found in the buildings was slightly lower on the top floor than on the bottom floor. No eye or respiratory health problems was found among the flocks. The present study provides a glimpse on air quality inside hatching egg productions, and on airborne contaminants known to be responsible for health issues in both animals and humans.

2AA.3

Dispersion Modelling of Bioaerosols Emitted from Livestock Operations: Fate of Microbes and Antibiotic-Resistance Genes.

JOANIE LEMIEUX, Patrick O'Shaughnessy, Araceli Dalila Larios Martínez, Marc Veillette, Valérie Létourneau, Nathalie Turgeon, Cindy Dumais, Stéphane Godbout, Caroline Duchaine, *Université Laval*

Introduction. Confined animal feeding operations (CAFOs) are important producers of bioaerosols. CAFOs can have mechanical ventilation systems from which a proportion of indoor bioaerosols is emitted through the fans. CAFOs bioaerosols can contain microorganisms and antibiotic-resistance genes (ARGs). These contaminants have the potential to disseminate and travel unknown distances from the barns with unknown impacts on surrounding communities and environment.

Objective. Evaluate microbial and ARGs emissions from two conventional pig finishing buildings (PFB) and broiler chicken barns (BCB) to model their dispersion in the environment using AERMOD.

Methods. Indoor bioaerosols were collected on filters using the SASS® 3100 Dry Air Sampler. DNA was extracted from filters and used for quantification by PCR of ARGs and bacterial biomass (16S rRNA genes). PFB and BCB were visited three times in the warm season for bioaerosols sampling. Ventilation rates were measured (m^3/h) directly at the fan exhaust. Emissions (gene copies/h) were then calculated and used in AERMOD software to model the dispersion of bioaerosols components from CAFOs according to meteorological data and topography.

Preliminary results. Mean emissions of total bacterial biomass (16S rRNA geneS) ranged from 10^{11} to 10^{12} gene copies/h for the four CAFOs. Some ARGs detected indoor such as *aac(3)* (aminoglycoside), *blaTEM* (beta-lactams), *sul1* (sulfonamide), *tetM* (tetracycline) and *vanA* (vancomycin) were emitted at 10^9 gene copies/h. Those emission rates data were used to feed the AERMOD model and evaluate the dispersion of bioaerosols up to 10 km away from the barns. Analyses are underway.

Implication. The use of dispersion models will help to understand how bioaerosols components behave once emitted outdoors and up to what distance their concentrations are significant. Those incoming results will help understand at which extent people living nearby CAFOs are exposed to bioaerosols containing potentially harmful pathogenic agents.

2AA.4

Conifer Needles as Passive Air Samplers for Biomonitoring Emissions from Swine Farms.

SAMANTHA LECLERC, Paul George, Florent Rossi, Nathalie Turgeon, Marc Veillette, Caroline Duchaine, *Université Laval*

Background:
Swine barns continuously emit substantial quantities of bioaerosols into the environment, which can subsequently travel long distances. Active air samplers are still the gold standard for quantifying these emissions; yet they often fail to capture long-term emission patterns and peak emissions. Swine barns are frequently surrounded by conifers hedges known to bioaccumulate bacteria from local sources. This project therefore explores the potential of conifer needles as passive air samplers for quantifying bacterial and viral emissions from swine barns.

Procedure:
Two swine barns were selected, each surrounded by two conifer hedges positioned at distances of 10m and 50m, and 30m and 60m, respectively. Approximately 240m^3 of air was actively collected near the hedges and directly at the exhausts, along with 15g of conifer needles from each distance. For comparison, air and needles were collected from two control sites located six kilometers away from any farm or industrial activities. DNA was extracted from samples and the presence of key bioaerosol markers from the barns (total bacteria (16S rRNA gene), pig DNA, *Enterococcus*, archaea and an *Aerococcus viridans* phage) was tested by qPCR.

Findings:
The air at the barns exhausts harbors considerable concentrations of the monitored biomarkers that decrease rapidly with distance, reaching comparable values to those of the control sites at the second hedge. Conifer needles partly mirrored the active air sampling: all markers decreased with distance but remained higher when compared to control sites even at the second hedge, potentially highlighting long-term bioaccumulation. Total bacteria remained constant, likely reflecting the needles' inherent microbiota.

Implications:
Conifer needles effectively bioaccumulate specific markers of swine emissions, demonstrating their potential as an alternative to traditional active samplers for long term biomonitoring of bioaerosol emissions from agricultural facilities. Further research is underway to estimate the consistency of conifer phyllosphere under different types of pollution exposures.

2AA.5

Evaluating Airflow Rates in Traditional and Alternative Egg Production Farms Equipped with Mechanical Ventilation through Direct and Indirect Measurements. Andrea Katherin Carranza Diaz, ARACELI DALILA LARIOS MARTÍNEZ, Magali-Wen St-Germain, Valérie Létourneau, Caroline Duchaine, Stéphane Godbout, Sébastien Fournel, *Research and Development Institute for the Agri-environment*

The poultry industry is increasingly pressured to enhance animal welfare standards in Canada and globally. As part of this trend, accurately estimating emissions of gases, dust, and bioaerosols from animal housing is critical for assessing environmental and social impacts. Ventilation rate (VR) is a crucial parameter in emission estimation and is influenced by various factors, including environmental conditions, animal behavior, building characteristics, and ventilation system type. However, existing methods for VR calculation often entail significant uncertainty. Visits were made to different egg-producing farms in southern Quebec. The selection of farms was based on the type of production systems (enriched cages (EC), cage-free systems (CFS), conventional egg production (CP)), the number of laying hens, the geographic location of farms, and the availability of producers to participate in the study. CO_2 concentration, air velocity, humidity, and temperature were measured in the barns. At the same time, the building and ventilation system were characterized. The average results showed that the VR [m^3 h^{-1} hen^{-1}] by the direct method were CC = 0.6, EC = 0.5, CFS = 0.7; by CO_2 balance were CC = 0.7, EC = 0.6, CFS = 1.1 and finally by heat balance were CC = 0.8, EC = 0.9, CFS= 0.9. VR values calculated by the three methods were closer for the CP systems and more dispersed for EC and CFS systems, respectively. Corrections factors need to be determined under controlled conditions to improve the estimation of VR by direct and indirect methods. These efforts are crucial for advancing the accuracy of ventilation rate assessments in poultry housing, ultimately contributing to improved environmental and welfare outcomes in the industry.

2AA.6

Assessment and Characterization of Bioaerosol from Residential Area of Naini, Prayagraj, Uttar Pradesh, India. HARISON MASIH, *SHUATS, (Allahabad) Prayagraj, Uttar Pradesh, India*

Bioaerosol are ubiquitous very small in size and light weight airborne particles that characterized as the biological materials such as Bacteria, actinomycetes, fungi, viruses and debris that can be isolated from indoor, outdoor environment viz. agriculture farms, industrial, residential, office and construction areas, that causes the breathing and respiratory problem, that has drawn an attention on health issues in the society. The investigation was conducted from April to May, 2024 and sampling of bioaerosol was performed by passive air monitoring (settle plate method), from six different area near Agriculture Institute Naini) the major air pollutants in Prayagraj and weather conditions were recorded in average PM2.5=27.5, PM10=86.39, SO2=10.9µg/m3, CO=220.9µg/m3, NO2=2.9µg/m3 and OZONE=14.6µg/m3. Temperature 37.8°C, humidity=12.1, AQI=70.8, pressure=75.4 and wind speed=19.39km/h. Media plates of NA and PDA were exposed in the indoor and outdoor areas for 15-30minutes, and then plates were incubated at required conditions. Bioaerosol viable microbial plate count was recorded and selected colonies were identified by gram's staining, Lacto-phenol and biochemical methods. Bacterial and fungal count from indoor and outdoor air samples were observed minimum 5167 & 18,792(CFU/m3), maximum 42,593 & 65,144 (CFU/m3) and on PDA medium minimum 5008 & 8137 (CFU/m3) maximum 6887 & 15,344 (CFU/m3) respectively. Genus of bacteria such as gram negative species and gram positive Bacillus species, Staphylococcus spp., Micrococcus spp., and Yeasts and molds like., Saccharomyces spp., Aspergillus niger, Aspergillus fumigatus, Aspergillus flavus, Aspergillus spp., Alternaria spp.,, Mucor spp., and Penicillium spp., microbes may cause infections viz. respiratory diseases, asthma, influenza, eye infection and allergic infections, bioaerosol release endotoxins and Mycotoxins, during cell lysis. Microbial activity poses significant threat to health risks and adverse impact on human life.

Keywords: Bioaerosol, air pollutants, environmental factors, microbial contamination, respiratory infection and Public health.

2AA.7

Comparison of Two Air Samplers for Outdoor Monitoring of Low Concentration Bioaerosols and Antibiotic Resistance Genes.

NATHALIE TURGEON, Mahsa Baghdadi, Samantha Leclerc, Amélia Bélanger Cayouette, Joanie Lemieux, Patrick Brassard, Stéphane Godbout, Caroline Duchaine, *Université Laval*

Background: Various activities such as intensive farming and wastewater treatment can generate bioaerosols containing antimicrobial-resistant microorganisms, which carry antibiotic resistance genes (ARGs). These bioaerosols can travel long distances outdoors, necessitating a better understanding of ARG emission and dispersion for the development of mitigation strategies. This study aimed to develop an outdoor air sampling strategy suitable to monitor bioaerosols (including ARGs) emitted outdoors.

Procedure: Two high flowrate air sampling devices (SASS3100 at 300 L/min and SASS4100 at 4000 L/min) were used to collect upwind, on-site, and downwind of wastewater treatment plants, animal feeding operations, and during manure spreading activities, both in an experimental wind tunnel and on farmland. Samples were analyzed using qPCR for the quantitation of total bacteria, fecal indicators, and 38 ARGs.

Findings: Both SASS3100 and SASS4100 proved suitable for outdoor air sampling near barns, wastewater treatment plants, and during manure spreading activities. However, SASS4100 underestimated concentration in the air by a factor of 5 compared to SASS3100. Nevertheless, SASS4100 exhibited better sensitivity for ARGs and fecal indicators detection due to its collection of a 13x larger air volume during a similar sampling time. Fifty percent of samples collected with the SASS4100 tested positive for ARG compared to 33% of samples collected with SASS3100 near wastewater treatment plants. Among samples collected during manure spreading in a wind tunnel with SASS4100, 35% tested positive for ARGs and 89% tested positive for fecal indicators, compared to 31% for ARGs and 87% for fecal indicators for those collected with SASS3100. Samples collected during spreading on farmland were on average 5x less concentrated compared to those collected during spreading in a wind tunnel, suggesting fugitive emissions in all directions.

Implications: This study highlights challenges and limitations of outdoor air sampling and proposes a comprehensive strategy for bioaerosols and ARGs surveillance.

2AA.8

Water-based Cooling Strategies for Livestock Operations: A Potential Source of Waterborne Respiratory Pathogens Bioaerosols.

NYCKIE ALBERT, Valérie Létourneau, Vicki Clouet-Côté, Araceli Dalila Larios Martínez, Stéphane Godbout, Caroline Duchaine, *Université Laval*

Global warming is accelerating the implementation of water-based cooling strategies (e.g., fogging systems, cooling pads) inside confined livestock operations since heat-stressed animals imply low weight gain, low reproducibility, deaths, and therefore significant economic losses. However, these strategies may be associated with multiplication of opportunistic waterborne pathogens (e.g., Legionella, mycobacteria) inside water pipes and reservoirs (stagnant water, biofilms) and, their consequent aerosolization when cooling strategies are being used. The present project aimed to evaluate by qPCR the presence of waterborne respiratory pathogens (e.g., *Acinetobacter baumanii*, *Legionella pneumophila*, *Pseudomonas aeruginosa*, *Mycobacterium avium*) in water, surface, and air samples taken in pig buildings (finishing swine, gestating sow) using cooling pads and/or fogging systems. Sampling campaigns took place at the beginning, middle and at the end of the warm season. At the beginning of the warm season, *Legionella* spp. (up to 10^3 per ml or surface) and *Mycobacterium* spp. (up to 10^7 per ml or surface) were already present in water and surface samples of the fogging systems and cooling pads. The presence of *Acinetobacter baumanii* was revealed in a few water and surface samples of the fogging systems and cooling pads but often at concentrations close to the detection limit of the qPCR protocol. On-going deeper analysis will determine if the presence and concentrations of waterborne respiratory pathogens increase during the warm season. These primordial results will determine if water-based cooling systems could lead to waterborne respiratory pathogens aerosolization inside confined livestock buildings and then be a health issue for animals and workers.

2AA.9

Modeling Gaseous Nitrogen Emissions from Soils and Their Impacts on Atmospheric Chemistry.

BRIAN GAUDET, ManishKumar Shrivastava, Jie Zhang, Quazi Rasool, Jerome Fast, Rahul Zaveri, Sheng-Lun Tai, *Pacific Northwest National Laboratory*

Near urban areas, anthropogenic emissions of oxides of nitrogen (NO) are often the dominant contributor to atmospheric NOx chemistry, however, in rural areas away from urban centers, emissions of NO from soil due to microbial processes could be significant. Soil microbial nitrogen emissions have been thought to make up 20-25% of total NO emissions globally. These emissions are a product of both nitrification and denitrification processes in the soil, but the relative rates of emissions of different nitrogen-containing species (e.g., NO, NH3, HONO, N2) are functions of soil properties such as temperature, moisture content, pH, and soil carbon and nitrogen pools. Within chemical transport models, when soil NO emissions are included, these emissions are frequently expressed as simple functions of available soil nitrogen. However, realistic simulations of the contributions of soil NO emissions to atmospheric chemistry at regional and subannual temporal scales requires representing the impacts of the variations in soil temperature and moisture content on soil nitrification and denitrification rates. Towards that end, we have implemented mechanistic soil NO and NH3 parameterizations that are calculated online using inputs from geographical databases and from an explicit soil biogeochemical model within the Weather Research and Forecasting Model coupled to Chemistry (WRF-Chem). We then simulate both the spring and summer times during the 2016 HISCALE field campaign over the Southern Great Plains (SGP), and evaluate the predicted concentrations of various species (NOx, ozone, aerosols) against measurements. We show how the differences in the meteorology during the spring and summer lead to differences in the contributions of soil NO emissions to atmospheric chemistry, and highlight large regional differences due to heterogeneous soil surface properties.

2AA.10

Antibiotic Resistance Genes in Air Near Swine and Dairy Farms.

DAVID KORMOS, Gabriel Isaacman-VanWertz, Jactone Ogejo, Amy Pruden, Linsey Marr, *Virginia Tech*

The spread of antimicrobial resistance is a global health threat, and there is an urgent need to identify how it disseminates. To date, most studies on environmental antibiotic resistance genes (ARGs) have focused on water or soil, but airborne ARGs are also important due to their ability to undergo long-distance transport. To gain insight into sources of ARG emissions to the atmosphere from livestock facilities, we characterized ARGs in aerosol particles collected at a swine farm and dairy farm across all seasons. At the swine farm, concentrations of total bacterial markers (16S rRNA genes) and a common anthropogenic indicator ARG (sul1) were significantly elevated at building exhaust vents compared to an upwind location, with differences up to two orders of magnitude. Seasonal variation was evident, with the highest 16S rRNA and sul1 gene concentrations in spring and fall, up to 2x104 gene copies per cubic meter (gc/m^3) for sul1. Both genes were predominantly associated with larger particles, with sul1 also found in fine particles (<2.5 µm), indicating potential for long-distance transport. At the dairy farm, where samples were collected at varying distances from an open-air barn, the 16S rRNA gene concentrations were highest in the fall and lowest in the winter. Conversely, sul1 concentrations were highest in the winter. Downwind from the dairy barn, 16S rRNA gene concentrations decreased up to 25 meters away, while sul1 gene concentrations showed no clear downwind pattern in fall and spring, suggesting a link to ambient background levels rather than dominance of the barn as a source. Culturing results showed a higher ratio of antibiotic-resistant to non-resistant colonies at the swine farm in the spring, correlating with increased use of the building's exhaust fan. Colonies have been preserved for further analysis by whole genome sequencing.

2AA.11

Strategies for Improving Air Quality in Next-generation Livestock Buildings Integrating Animal Welfare Considerations. ARACELI DALILA LARIOS MARTÍNEZ, Valérie Létourneau, Vicki Clouet-Côté, Inès D Dhib, Caroline Duchaine, Sébastien Fournel, Alexis Ruiz-González, Magali-Wen St-Germain, Laurianne Gratton, Andrea Katherin Carranza Diaz, Mahsa Baghdadi, Stéphane Godbout, *Agri-Food Engineering Division, Research and Development Ins*

The transition from conventional to next-generation livestock buildings, incorporating considerations for animal welfare, has been occurring over recent years. While next-generation facilities offer increased freedom of movement for animals, they may potentially exacerbate air quality issues due to increased animal activity, larger areas for excretion, and increased nutritional requirements. Exposure to emissions such as ammonia (NH3), particulate matter (PM), and bioaerosols has been linked to both animal and human health concerns, including infections and non-infectious diseases such as reduced lung function, asthma, chronic bronchitis, and hypersensitivity pneumonitis. Factors influencing NH3, PM and bioaerosol emissions include litter and manure management, environmental conditions, ventilation rate, as well as animal mobility within the facilities. To assess the impact of transition to these new production systems, concentrations of NH3, PM, and bioaerosols, as well as environmental conditions and ventilation rates, were measured in both conventional and next-generation livestock buildings across various housing systems. They included cage and cage-free laying hen housing, caged and group housing systems for gestating sows, and tie-stall and free-stall housing for dairy cows. Subsequently, literature reviews were conducted to identify and compare available mitigation strategies aimed at improving air quality in livestock buildings. Following this, discussions were held with expert panels to select the most relevant strategies for implementation in next-generation facilities. Selected strategies were then tested in commercial barns. For example, in a commercial aviary housing 20,000 birds per floor, the efficacy of sprinkling a water-oil acid emulsion on litter surfaces was evaluated. Similarly, at a gestating sow barn with 405 sows housed in separate gestation group pens, the impact of varying slurry removal frequencies and room temperature adjustments was examined. Additionally, in a commercial free-stall dairy barn housing 93 dairy cows, the effectiveness of sprinkling a bedding additive (biolitter) is currently under evaluation. To assess the efficacy of these mitigation strategies, concentrations of NH3, PM, and bioaerosols were measured before and during the trial period, alongside monitoring of temperature, humidity, and airflow rates. This paper aims to present the results and the overall impact of these efforts on improving air quality in next-generation livestock buildings.

2AA.12

Seasonal Variations in Microbiome Composition in a Residential Chicken Coop. JOHN CATE, Maria King, *Texas A&M University*

The study of bioaerosols in residential chicken coops to determine microbiome composition remains under-researched, as most existing literature focuses on the commercial aspects of poultry farming. According to the American Pet Producers Association, approximately 10 million U.S. households kept chickens in 2018, with this number rising due to increasing egg prices. This study, conducted in a residential chicken coop in Texas across various seasons and weather patterns, seeks to delineate fluctuations in the microbiome composition accurately. Testing involved closed and open coop setups, allowing for comparisons between minimal airflow environments in cold weather and open setups in other seasons.

Bioaerosol sampling was carried out using high air volume 100 L/min wetted wall cyclone bioaerosol collectors 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, 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 for microbiome composition using Illumina sequencing.

Microbiome analysis comparing results from two winter tests and one summer test has been completed, providing important insights into seasonal variations in the microbiome composition within residential chicken coops. Additional analysis was conducted for wind-borne bioaerosols dispersed from these coops to surrounding neighborhoods and farms, potentially affecting millions of homeowners.

The results show that moving around the coop resuspends hundreds of bacteria per liter of air, exposing people to potentially pathogenic microorganisms with antibiotic resistance. This study suggests that proper ventilation and frequent litter removal could protect individuals working in residential chicken coops from inhaling harmful levels of bioaerosols.

2AA.13

Applying CRISPR-Cas Technology to Bioaerosol Environmental DNA for the Monitoring of Pathogenic Species Such as P. Infestans.

DAVID O'CONNOR, Weili Guo, Ciara Mcdermott, Steven Kildea, Anne Parle-McDermott, *Dublin City University*

Pathogenic plant microorganisms such as oomycetes, fungi, viruses and bacteria pose a serious threat to food security and negatively impact the agricultural ecosystem. Fungal infection along is accounted for up to 23% of global crop loss. Monitoring airborne plant pathogens is vital in terms of identifying pathogenic species, tracking their movement, therefore developing precision pesticides spraying program and preventing outbreaks.

Current molecular PCR-based detection methods are not suitable for ‘on-site’ early detection due to the requirement of sophisticated lab-based equipment such as Light Cycler. In recent year, environmental DNA (eDNA) has become a powerful tool for monitoring various species in surrounding environment (Williams et al., 2019). In this project, genetic material in eDNA extracted from ambient air samples will be evaluated using isothermal-based RPA method coupled CRISPR-Cas12a detection platform, the presence or absence of specific plant pathogen such as phytophthora infestans will be detected via both fluorescent and colorimetric techniques. Mycelia genomic DNA samples from phytophthora infestans and three close relative species were used for the assay development, mitochondrial sequences of phytophthora infestans and the three off-targets obtained from GenBank were used for gRNA and primer design, air samples collected by a multi vial cyclone sampler (Burkard, UK) were used for eDNA extraction.

Using the collateral cleavage activity of Cas12a, RPA coupled CRIPSR-Cas12a assay, as a proof-of-concept, revealed the specific detection of phytophthora infestans at constant temperature of 37 o C with single detection at 0.85fM. The presence of phytophthora infestans in one out of seventeen air samples were determined by both FAM-mediated fluorescent assay and colorimetric-based lateral flow assay.

2AC.1

Uncertainty Analysis for Kinetic Simulation of Alpha-Pinene Ozonolysis SOA Formation based on Explored Chemical Processes.

Chuanyang Shen, HAOFEI ZHANG, *University of California, Riverside*

As one of the most abundant monoterpenes in the atmosphere, α-pinene ozonolysis is a critical pathway in the atmospheric chemistry of volatile organic compounds (VOCs), significantly influencing air quality and climate. Its oxidation products contribute substantially to aerosol mass, especially in forested areas. In this study, we present a comprehensive analysis of α-pinene secondary organic aerosol (SOA) formation via ozonolysis, using a 0-D kinetic modeling framework to simulate gas-phase reactions and subsequent SOA formation based on near-explicit chemical mechanisms which have been explored in prior work. We compare our simulation results with both existing chamber experiments and field measurements. This study aims to evaluate how different chemical mechanisms and treatments of specific processes affect the prediction of SOA yields and compositions. Moreover, we explore the effects of RO2 unimolecular autoxidation rates, alkoxy radicals' fates, particle-phase reactions, and volatility saturation concentration (C*) estimation on aerosol formations and found that these factors can bring great uncertainty to the SOA prediction. Specifically, a reduction in all autoxidation rates by a factor of 10 from the default values based on prior computational calculations can lead to an approximately 40% reduction in SOA formation. Employing two C* estimation methods, SIMPOL and EPI, we found that that SIMPOL predicts significantly lower volatilities than EPI. These results underscore the substantial uncertainty associated with detailed chemical mechanisms and C* estimations in SOA modeling.

2AC.2

Unexpected Stereochemical Specificity for Organosulfates Formed from Isoprene-Epoxide Ring Opening Reactions as a Function of Aerosol Acidity. ANDREW AULT, Madeline Cooke, N. Cazimir Armstrong, Cara Waters, Qiyuan Zhao, Scarlet Aguilar-Martinez, Yuzhi Chen, Ziying Lei, Zhenfa Zhang, Avram Gold, Paul Zimmerman, Jason Surratt, *University of Michigan*

Chirality is a central property of organic molecules that plays a key role in chemical properties and biological impacts of molecules with only a slight difference at a single stereocenter within a molecule. In secondary organic aerosol (SOA) species with different stereoisomers are assumed to be present equally within racemic mixtures, unless there is an initial stereospecificity of the condensing or reacting oxidized VOCs. Unexpectedly, we found that certain stereoisomers of organosulfates are formed preferentially from isoprene epoxydiols without initial stereospecificity. In addition, we see a pH-dependent shift in the mechanism of reaction from an SN1 dominating the lowest acidities studied to an increase in the concerted SN2 mechanism at higher pH values. These findings were supported by computational chemistry analysis of underlying reaction pathways that reveal the origins of selectivity. These results were enabled through a combination of advanced analytical methodologies, specifically hydrophilic interaction liquid chromatography coupled with mass spectrometry (HILIC/ESI-HR-QTOFMS) that can separate the MTS diastereomers and computational chemistry studies using advanced sampling methods to explore the reaction mechanisms. Identifying this unexpected chirality from racemic precursors and connecting it to mechanisms occurring within atmospheric aerosols has broad importance for SOA chemical composition, physicochemical properties, and potentially human health after inhalation. Further studies are needed to determine the breadth of this chirality within aerosols and its potential implications.

2AC.3

Atmospheric Aerosol Sulfur Distribution and Speciation in Mexico City: Sulfate, Organosulfates, and Isoprene-Derived Secondary Organic Aerosol from Low NO Pathways. MADELINE COOKE, Cara Waters, Joel Asare, Jessica Mirrielees, Andrew Holen, Molly Frauenheim, Zhenfa Zhang, Avram Gold, Kerri Pratt, Jason Surratt, Luis Ladino, Andrew Ault, *University of Michigan*

Poor air quality is a persistent challenge in Mexico City, and addressing this issue requires an understanding of the chemical composition of fine particulate matter, $PM_{2.5}$ (particulate matter less than 2.5 µm in diameter). Sulfate and secondary organic aerosol (SOA) are two of the largest contributors to $PM_{2.5}$ in Mexico City, but uncertainties exist regarding their sources, distribution across individual particles, and ability to form organosulfates. Herein, we show using electron dispersive x-ray spectroscopy that only 41±1% and 25±1% of particles (aerodynamic diameter, 0.32 – 0.56 µm) by number at two sites in Mexico City, respectively, contain sulfur. Vibrational spectroscopy (Optical-Photothermal Infrared + Raman Microspectroscopy) shows that these sulfur-containing particles consist of inorganic sulfate (SO_4^{2-}) and organosulfates ($ROSO_3^-$). In addition, we unexpectedly measured abundant isoprene-derived SOA from low nitric oxide reaction pathways, specifically organosulfates (methyltetrol sulfates = avg. 50 ng/m^3, max. 150 ng/m^3) and polyols (methyltetrols = avg. 70 ng/m^3, max. 190 ng/m^3) using hydrophilic interaction liquid chromatography coupled to electrospray ionization high-resolution mass spectrometry. Differences in SO_2 and NO_x concentrations between sites likely contribute to these spatial differences in sulfate, organosulfate, and SOA formation. These findings improve understanding of sulfur distribution and sources of SOA in Mexico City, which can inform efforts to improve air quality.

2AC.4

Determination of HCl Solubility in Proxies for Wildfire Smoke Aerosol.

RAE POOLEY, Megan Willis, *Colorado State University*

The stratospheric ozone layer, which protects us from harmful UV radiation, is anticipated to recover by approximately 2066 following global production bans of most long-lived gaseous halocarbons, the primary sources of catalytic ozone-destroying chlorine radicals. Reactive stratospheric chlorine mostly resides in reservoir species such as hydrogen chloride (HCl) and is efficiently re-released when the reservoirs partition to and undergo multiphase reactions on stratospheric particles. Large wildfire blowups, becoming increasingly frequent with climate change, can inject aerosol into the stratosphere. Modeling studies suggest the observed negative ozone perturbations after wildfire events arise from the high solubility of HCl in organic particle matrices compared to sulfuric acid background particles. However, existing HCl solubility data are limited for organics pertinent to aged wildfire aerosols, introducing uncertainty in models relying on these fundamental physical-chemical properties to predict the effect of wildfires on ozone layer recovery.

To quantify how organic molecular structure impacts HCl solubility, we employ a new method involving a closed recirculating system equipped with a Fourier transform infrared spectrometer that monitors concentration changes in gaseous HCl as it equilibrates with either a pure organic liquid or organic solution. By varying experiment temperature to produce solubility curves, we will measure HCl heats of solvation. We will also provide estimated contributions of HCl intermolecular interactions to measured (effective) solubility through composition measurements of resulting HCl-organic solutions. Results from our solubility measurements will facilitate more accurate stratospheric chemistry models by quantifying HCl solubility in carboxylic and dicarboxylic acids, acetates, alcohols, phenols, and carbohydrates.

2AC.5

Insights into Secondary Organic Aerosol Formation from Volatile Chemical Products.

HUAWEI LI, Don Collins, David R. Cocker III, *University of California, Riverside*

In the pursuit of improved air quality, regulatory initiatives have achieved notable success in mitigating traditional sources of emissions such as traffic and industrial activities. Nonetheless, the persistence of secondary organic aerosols (SOA) presents a formidable challenge. Recent investigations underscore the significance of volatile chemical products (VCPs) as a predominant urban source of organic emissions, particularly evident in regions like Los Angeles. Despite constituting a mere 4% of petrochemical products, VCPs contribute over half of urban volatile organic compound emissions in this locale (McDonald et al., 2018), underscoring the urgency for a comprehensive study of SOA formation from VCPs and their constituent chemicals.

This study aims to characterize SOA formation originating from VCPs, including personal care and household products, alongside their emitted precursors. Selection criteria for precursors were based on chemical composition and anticipated impact on SOA formation. Experimental assessments include SOA formation from both VCPs and individual ingredients, with comparative analyses between total SOA generated by ingredients and VCPs. Results indicate substantial SOA production from both complex VCP mixtures and individual ingredients. Notably, chemical transformations occurring during product formulation exert a pronounced influence on the formation of secondary organic aerosols (SOA) from volatile chemical products (VCPs), distinguishing their SOA formation from that of constituent ingredients. It emphasizes the necessity for further research to elucidate the air quality implications of personal care and household products.

2AC.6

Molecular Composition, Absorption, and Oxidative Potential of Urban Burning Aerosols. Qiaorong Xie, Katherine Hopstock, Kevin Ridgway, Jamie Cast, Shantanu Jathar, Alexander Laskin, Christian L'Orange, Sergey Nizkorodov, LUIS RUIZ ARMENTA, *University of California, Irvine*

Wildfires are an increasingly prevalent natural disaster worldwide, affecting our climate through smoke plume radiative effects and human health through smoke exposure. The number of large fires (10,000 acres or more) within the United States and the total area consumed has increased since the early 2000s. This increase is fueled by the onset of climate change and increased anthropogenic activities associated with housing developments in at-risk locations at the wild-land urban interface (WUI). While extensive work has investigated the molecular composition of biomass-burning aerosol (BBOA), the contribution from urban-burning aerosol (UBA) remains to be discovered. This poster overviews the molecular composition, absorption, and oxidative properties of UBA samples collected during the summer 2022 Burning Homes and Structural Materials (BHASMA) Campaign. During this campaign, materials (e.g., Structural wood, carpeting, and insulation) typical for a North American house were burned in smoldering pyrolysis or combustion. The chromophoric and molecular analysis of UBA done through liquid chromatography coupled with a photodiode array and high-resolution mass spectrometry (HPLC-PDA-HRMS) remains ongoing. Still, it suggests that in addition to well-known BBOA tracers, species such as levoglucosan and lignin decomposition products, plastics, and plasticizers are present in these samples. These additional chemical agents may alter the chemistry compared to BBOA studied in the past. In addition, we investigated the stability of chromophores with respect to solar UV exposure. Initial results indicate photobleaching and photoenhancement effects observed after UV aging for up to 6 hours and suggest untreated woods may experience this effect the most. This effect may depend on chemical treating agents applied to materials during manufacturing. Lastly, preliminary results collected from the dithiothreitol (DTT) assay, representative of antioxidant depletion in cells, suggest that treated wood and manufactured materials have higher OPDTT. This again implies that the manufacturing process alters UBA composition compared to previously studied BBOA.

2AC.7

Global and Regional Simulations of EPFR Concentrations and ROS Formation in Lung Lining Fluid. MEREDITH SCHERVISH, Regina Luu, Simon Rosanka, Pascale Lakey, Annmarie Carlton, Manabu Shiraiwa, *University of California, Irvine*

Environmentally persistent free radicals (EPFRs) in PM have received growing attention for their potential toxicity as they are redox active to form reactive oxygen species (ROS). EPFRs are formed from incomplete combustion, including biomass burning and vehicle exhaust. Their long atmospheric lifetime implies that, in addition to their main local sources, long-range transport may impact local concentrations of EPFRs. Measurements of EPFRs in PM have been conducted across the globe with concentrations ranging from 10^{16}-10^{20} spins/g of PM and have been shown to vary with different emissions sources as well as meteorological conditions. In this work, we estimate EPFR concentrations across the globe from GEOS-Chem and in the Southern California region using CMAQ. We utilize tight correlations between emission markers of biomass burning and vehicles and EPFR content in particulate matter. EPFR, iron, copper, and PM2.5 concentrations are then used as inputs to the KM-SUB-ELF model in order to predict the concentrations and production rates of ROS in the epithelial lining fluid (ELF).

2AC.8

Simulations of Cloud and Aerosol-phase Sulfate Formation Using GAMMA 6.0. SANDHYA SETHURAMAN, Zifeng Tang, Kedong Gong, Vicki Grassian, V. Faye McNeill, *Columbia University*

Analysis of haze events under highly polluted conditions has indicated a gap in our understanding of the formation of particulate sulfate. In particular, air quality modeling studies inferred the importance of aerosol-phase S(IV) oxidation, which had previously received less attention than cloud water processes. Given the multitude of S(IV) oxidation pathways and their sensitivity to parameters such as ionic strength and pH, more data were needed before these processes could be incorporated into models. In the past decade laboratory studies have filled in this gap, with a proliferation of proposed mechanisms for sulfate formation in the aerosol phase and at the gas-aerosol interface.

We have updated the Gas Aerosol Model for Mechanism Analysis (GAMMA) to include updated S(IV) oxidation chemistry for cloudwater conditions following current recommendations (Tilgner et al. 2021), in addition to pH tracking and transition metal ion cycling. For aerosol conditions, we have implemented recently recommended mechanisms from the literature for S(IV) oxidation via HOOH, ROOH, NO2, TMI catalyzed processes and uncatalyzed oxidation, as well as updated organosulfate formation chemistry. Results will be presented for sensitivity studies performed under Beijing winter conditions, urban US, and rural conditions, and trends will be discussed.

2AC.9

AMORE V2.0: A Comprehensive Algorithm for the Automated Model Reduction of Atmospheric Oxidation Mechanisms. FORWOOD WISER, V. Faye McNeill, Siddhartha Sen, Daniel Westervelt, Daven Henze, Arlene Fiore, Julia Lee-Taylor, Kelley Barsanti, John Orlando, Zhizhao Wang, *Columbia University*

The Automated Model Reduction (AMORE) version 2.0 Algorithm is a comprehensive algorithm for the reduction of atmospheric oxidation mechanisms of organic species. This algorithm is a follow up to the AMORE v1.0 algorithm presented in Wiser et al., GMD (2023). Unlike AMORE v1.0, AMORE v2.0 creates reduced mechanisms of any size and does not require any additional manual input. The algorithm employs graph theory techniques to measure the yields of all species in the mechanism, sort them by importance, group them when applicable, and remove species while maintaining mechanism accuracy. Reduced mechanisms can be generated within minutes with a specified size for the given application. Accuracy of mechanism properties, such as secondary organic aerosol formation and concentration of low volatility products can be preserved as well. Example reductions are demonstrated for the isoprene oxidation mechanism (430 species) and the larger GECKO-generated camphene oxidation mechanism (180,000 species). This algorithm has broad potential for the reduction of oxidation mechanisms to allow for their use in transport models, which can only utilize smaller mechanisms due to computational constraints.

2AC.11

Direct Determination of Melting Temperatures for Individual, Sub-Micron α-Pinene Derived Secondary Organic Aerosol Particles. KATHERINE KOLOZSVARI, Natasha Garner, David Bell, Jens Top, Markus Ammann, 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 are 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 internal phase separation. 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 α-pinene ozonolysis. 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. We investigated the influence of inorganic material on the viscosity of this SOA by comparing the T_m of SOA formed with and without the presence of ammonium sulfate seed particles. Additionally, we determined the impact of higher volatility molecules on particle viscosity by comparing the T_m of particles before and after undergoing thermal denuding to evaporate any high volatility material.

2AC.12

Photooxidative Fate of Atmospheric Methylated Selenium Compounds. ERIN BOWEY, Alexa Canchola, Michael Lum, Linhui Tian, Kunpeng Chen, Ying Zhou, Don Collins, Ying-Hsuan Lin, Roya Bahreini, *University of California, Riverside*

Methylated selenium (Se) compounds are subjected to oxidative conditions upon their release into the atmosphere, leading to the formation of Se-containing secondary aerosol (SA). The formation potential of this SA in terms of possible reaction pathways and product yields will largely govern its eventual fate in the environment and toxic effects on human health. Exploring factors including the speciated mass concentration and the gas-to-particle (G/P) partitioning is instrumental to understanding SA formation potential. With these goals, photooxidation experiments of the precursor species dimethyl selenide (DMSe) and dimethyl diselenide (DMDSe) were carried out in an environmental chamber under both low- and high-NOx conditions. A mini Aerosol Mass Spectrometer (mAMS) alongside a Scanning Mobility Particle Sizer (SMPS) were used to investigate online composition and size distribution of the formed aerosol products. After the maximum experimental SA mass concentration was reached, a denuder-filter system coated with derivatizing agent O-(2,3,4,5,6-Pentafluorobenzyl)hydroxylamine (PFBHA) was used to separately collect the gas- and particle-phase carbonyl products. These samples were then analyzed offline by GC-MS to follow G/P partitioning behavior. The average particle density for each condition was calculated from mAMS and SMPS data. Standards of two expected products, methaneseleninic acid and selenic acid, were also sampled by mAMS. Signature fragments of these species were used to quantify their contribution to the organic and inorganic fraction of the total SA formed in the chamber experiments. The methaneseleninic acid contributed a broad range of 1-80% to the total organic Se-containing SA mass concentration, depending on the precursor and NOx level, while 80±20% of the inorganic Se-containing SA was consistently attributed to selenic acid. Consolidation of these complementary measurements will refine our overall understanding of the atmospheric chemistry of methylated Se species under various oxidative conditions.

2AC.13

Ozonolysis of Polycyclic Aromatic Hydrocarbons on the Surfaces of Secondary Organic Aerosol Particles and its Effects on Particle Properties. ALLA ZELENYUK, Kaitlyn J. Suski, ManishKumar Shrivastava, Simeon Schum, Lynn Mazzoleni, *Pacific Northwest National Laboratory*

Polycyclic aromatic hydrocarbons (PAHs) are toxic byproducts of combustion that can undergo long-range transport into remote regions of the world. Previously we have shown that when secondary organic aerosol (SOA) particles are formed in the presence of gas-phase PAHs, PAHs become incorporated entrapped inside viscous SOA particles, shielded from evaporation and oxidation, thus enabling their long range transport. In turn, the presence of PAHs during SOA formation increases SOA number concentration, mass loadings, and makes these particles less volatile and more viscous. In contrast, PAHs deposited on the surface of SOA particles, evaporate quickly and do not alter the SOA volatility.

In this work we show that in the presence of ozone PAHs can undergo heterogeneous oxidation on the surfaces of SOA particles, forming shells that alter the evaporation kinetics of the resulting particles. SOA was formed via ozonolysis of α-pinene and was exposed to gas-phase PAHs (anthracene or pyrene) and ozone for 1 hour, during which a shell composed of unreacted and oxidized PAHs was formed on the particle surfaces, as evident from particle growth and the mass spectra. Evaporation experiments on the resulting particles with core-shell morphology revealed that their volatility is lower compared to that of pure α-pinene SOA. Most notably, when evaporated under either dry (<5% RH) or wet (~75% RH) conditions, significant fraction of the PAHs and their oxidation products remained in the particles after a day.

These results suggest that PAHs can become incorporated into SOA particles at any time during their atmospheric evolution via adsorption and surface reactions with ozone, affecting the composition, morphology, and mass-transfer processes, including SOA evaporation kinetics. The data show that surface reactions of PAHs with ozone can result in higher loadings of SOA, PAHs and PAH oxidation products, leading to their longer than predicted atmospheric lifetimes.

2AC.14

Testing the Photosensitized Production of Sulfate Radicals in Ammonium Sulfate Aerosol Liquid Water Mimics. ANGELINA PETERSEN, Tran Nguyen, *University of California, Davis*

Organosulfates (OS) are ubiquitous in atmospheric aerosols and can modify aerosol-cloud interactions through reducing surface tension, yet many of their formation pathways are still poorly understood. Recently, it was reported that high ionic strength aqueous solutions of ammonium sulfate (AS) and other sulfate salts, representative of aerosol liquid water, can generate sulfur-containing radicals when irradiated with tropospheric sunlight, and thus initiate the formation of OS in the presence of organics. This work examines the hypothesis that chromophoric organic species, such as atmospheric brown carbon, can photosensitize the AS photochemistry under tropospheric conditions. The sulfate radicals may then add to a carbon-carbon double bond to form OS. We found that chromophores that can form triplet carbon excited states such as 3,4-dimethoxybenzaldehyde (3,4-DMB) decayed significantly and more rapidly when irradiated in the presence of AS than without. A sulfate radical trap with an aliphatic double bond was used to monitor the OS production yield. The variability in the OS yield between the irradiated high ionic strength AS + alkene solution, AS + alkene + chromophore solution, and their direct photolysis controls were investigated using high-performance liquid chromatography (HPLC) coupled to a high-resolution mass spectrometer (HRMS).

2AC.15

Recreating Explosion Conditions from Remnant Soot Aerosol.

JAMES E. LEE, Allison Aiken, Rachel Huber, Madeline Stricklin, Ryan Farley, *Los Alamos National Laboratory*

Soot generated by the detonation of explosive materials bear the signatures of the environment that they were formed in. Those environments are dictated by the explosive material, device construction, and oxygen availability. Conversely, analyzing particle composition and structure can provide forensic information about the explosive device. Here, we investigate soot from contained explosive experiments using a laser-vaporization high-resolution time-of-flight mass spectrometer (Aerodyne Research Inc. Soot-Particle Aerosol Mass Spectrometer, SP-AMS), a novel approach for post-detonation soot forensics. In contrast to standard solvation-based laboratory analysis, the SP-AMS is designed to directly measure particles providing the possibility of real-time results and analysis of single particles. Soot samples were collected from three detonation experiments using the same explosive materials and detonation configurations but changing the atmospheric conditions (either ambient atmosphere or oxygen-limited). We identify discriminating characteristics which include the abundance of black carbon, presence of fullerenes, incorporation of metals in black carbon bearing particles, and elemental ratios of organic-like material. These signatures were consistent in replicate explosive experiments and can be explained by known chemical reactions and particle formation dynamics following detonation. Forensic analysis with this approach can be performed on soot samples collected on air filters or scrapped from nearby surfaces. Chemical signatures were observed in bulk particle analysis where their characteristics are muted by the averaging of compositionally-varying particles. Our results provide a road map for future analysis investigating other high explosive materials and device constructions, analysis of single-particles where the signatures may be more distinct, and statistical classification strategies.

2AC.16

Evaluation of Long-term Monitoring of Polycyclic Aromatic Compounds across Canada under the National Air Pollution Surveillance Program.

ANDRZEJ WNOROWSKI, Valbona Celo, *Environment and Climate Change Canada*

Polycyclic aromatic compounds (PACs), considered prevalent atmospheric pollutants and which are regulated, have already been well characterized in the environment and are included in monitoring programs around the globe for compliance with air quality objectives. PACs have numerous origins usually associated with thermal decomposition of organic matter, such as from vehicular emissions, coal/wood/biomass burning, and industrial manufacturing. These persistent, toxic, and carcinogenic pollutants have been a focus of many studies around the world. The National Air Pollution Surveillance Program (NAPS) PAH dataset represents one of the longest high-quality datasets available globally from both urban and non-urban locations. Therefore, NAPS data provide highly comprehensive information regarding concentration trends and pollution sources for policy-makers' discussions over the need for regulations of reported pollutants. The data also ensures stakeholders have the science-based information to make decisions in regards to setting objectives and guidelines, and to evaluate effectiveness of already controlled pollutants.

This study presents the concentrations of 29 PACs in 24-hour gas phase and particulate matter integrated ambient air samples collected at selected NAPS sites, between 2002 and 2019. Temporal trends, seasonal effects, and major pollution sources at different types of sites (point-source, urban, near-road, background) will be presented and discussed.

2AC.17

Property Characterization and Continuous-Flow Measurements of Dark and Irradiated Methylglyoxal-Ammonium-sulfate Aqueous Aerosols. ERIN O'LEARY, Maia Merriman, Bruno Loyola San Martin, Katherine Pierre-Louis, Joseph Woo, *Lafayette College*

Methylglyoxal (MGLY), a commonly-observed carbonyl-containing volatile organic compound, has been observed to undergo a variety of shifts in composition and physical properties (e.g. UV-visible absorbance, surface tension, etc.) when processed with nitrogen-containing compounds and/or ultraviolet radiation. However, comparisons between aged and irradiated aerosol mimic solutions containing both MGLY and ammonium sulfate (AS) under bulk and small, hanging droplet (10µL) solutions have yielded discrepancies in SOA product compositions when exposed to UV light. As MGLY and proposed oligomeric products are expected to exhibit surfactant properties, it is proposed that SOA pathways that would not otherwise be possible are occurring at gas-droplet interfaces where surfactant SOA concentrations are locally high. This work expands on this comparison by assessing the relative yields of irradiated MG/AS reaction products under bulk, µL-scale hanging-droplet, and polydisperse aerosol measurements. UV/visible absorbance and ESI-MS data are reported. Effective amounts of oligomerization in irradiated MGLY/AS aerosol solutions are found to vary depending on duration of exposure to UV light and type of UV radiation applied (i.e. UV-A vs UV-C radiation.)

2AC.18

Modeling Size-dependent Processes in Multiphase Reactive Systems. Sandhya Sethuraman, Zifeng Tang, Kedong Gong, Adriane Tam, Vicki Grassian, V. FAYE MCNEILL, *Columbia University*

Many atmospherically relevant multiphase reactive systems exhibit behavior in laboratory studies that have led to those reactions being categorized as 'interfacial'. In this study, we analyze data from several such systems from an additive resistance perspective, considering various processes that could be taking place simultaneously, and their relative timescales. These include diffusion in the gas and aqueous phases, mass accommodation, reactions in the bulk, and reactions at the surface.

Typically, these systems exhibit a pattern involving a slow bulk reaction, and an efficient (although not necessarily fast) reaction at the surface. Above a critical radius, which varies among systems, the reaction is size-independent, and is governed by kinetics in the bulk. Below the tipping point, surface kinetics dominate and reaction rate is inversely proportional to droplet size.

We have developed a physicochemical modeling framework which can describe observed kinetic data from the literature from a range of systems involving S(IV) to S(VI) conversion, including: uncatalyzed O_2 oxidation, TMI-catalyzed oxidation, and H_2O_2, NO_2, and O_3 oxidation at various experimental conditions (RH, pH, initial oxidant concentration). This model accurately captures size-dependent kinetics and the critical radius, where applicable, for each system.

Using GAMMA 6.0, which contains updated S(IV) to S(VI) chemistry, we use a lab-to-environment approach to understand the implications of these interfacial processes under atmospherically relevant conditions, and offer recommendations based on this analysis for representing these systems in numerical models of atmospheric chemistry.

2AC.19

Aqueous Hydroxyl Radical (OH) Oxidation of Organosulfates.

SURBHI GUPTA, Tran Nguyen, *University of California, Davis*

Organosulfates (R-OSO3H), ubiquitous in atmospheric aerosols, are either formed in the atmosphere from aqueous chemistry or are directly released during biomass burning. Both the formation routes of organosulfates (OS) and their ability to react away during their long residence time in the atmosphere are areas of active study. Recent work in our group shows that the isoprene organosulfate has a relatively fast aqueous-phase reaction rate coefficient with hydroxyl radicals (OH). The heterogeneous OH oxidation of OS has been proposed to release the sulfate radical anion (SO4·−) alongside fragment products including smaller OS; however, a number of open questions remain regarding the fate of the sulfur moiety. As the reactive SO4·− is quenched by water to generate bisulfate ions and OH radicals, providing direct evidence of their formation in the aqueous phase is challenging. Our study investigates the aqueous photooxidation of organosulfates with OH radicals, focusing on stable product formation mechanisms and the potential radical propagation of SO4·−, which is capable of performing further cascade reactions with available reactive centers. Various OS with different chemical structures are tested. Analysis of the products is carried out with Nuclear Magnetic Resonance (NMR) and untargeted High Performance Liquid Chromatography coupled to High Resolution Mass Spectrometry (HPLC-HRMS).

2AC.20

Formation of Environmentally Persistent Free Radicals in Aromatic Secondary Organic Aerosols.

CAITLYN CRUZ, Kasey Edwards, Lena Gerritz, Manabu Shiraiwa, *University of California, Irvine*

Atmospheric particulate matter contains particle-bound free radicals, known as environmentally persistent free radicals (EPFR), that have a lifespan on the timescale of hours, days or longer. EPFRs are known to be redox active to generate reactive oxygen species (ROS) that may induce oxidative stress upon inhalation and respiratory deposition. Previous studies have shown that secondary organic aerosols (SOA) derived from oxidation of naphthalene and anthracene contain significant amounts of EPFRs. In this study, we generate SOA from aromatic precursors (naphthalene, toluene, indole) using an oxidative flow reactor. SOA generation and particle size distribution were monitored with a scanning mobility particle sizer (SMPS). We applied electron paramagnetic resonance spectroscopy to quantify concentrations of EPFRs. We varied several parameters such as volatile organic compound carrier VOC flow, relative humidity, and collection time to investigate their influence on EPFR yields. Preliminary results indicate that EPFRs can be generated from a single-ringed aromatic hydrocarbon and EPFR yields depend on precursors and SOA formation conditions.

2AC.21

Effect of Iron-Containing Mineral Dust on Photodegradation of Secondary Organic Aerosols.

ANTHONY JUE, Sergey Nizkorodov, *University of California, Irvine*

Mineral dust acts as a source of transition metals in the atmosphere. Iron is a common component in mineral dust particles, for example, in the form of hematite, iron (III) oxide. Secondary organic aerosol (SOA) compounds can react with iron and the oxidizers it produces by photocatalysis and/or Fenton chemistry. These photo-catalyzed reactions can result in changes to the SOA molecules, from oxidation to smaller compounds to oligomerization. To better characterize the effect of iron containing particles on SOA, hematite and Arizona Test Dust (ATD) are mixed with SOA particles and variable amounts of water, and irradiated with UV light. SOA is generated via flow tube ozonolysis of monoterpenes or photooxidation of aromatic compounds. For aqueous phase experiments, an SOA sample is extracted in water and photoaged to simulate several hours of solar irradiation, with a similar sample being aged in the presence of either hematite or ATD as a slurry, then filtered and analyzed via UPLC-HRMS to identify any major differences in the product profile after photoaging. For dry experiments, SOA is extracted in an organic solvent, Fe-containing particles are added, and the suspension is evaporated to dryness, leaving a film which can be similarly irradiated and the resulting photoaged film redissolved and similarly analyzed by UPLC-HRMS.

2AC.22

Investigating Aerosol Acidity through Ammonia Measurements Combined with Single Particle-Microspectroscopy.

ALI ALOTBI, Yao Xiao, Emily Costa, Kayleigh Reilly, Tiantian Zhu, Mitchell Rogers, Xu He, Cara Waters, Drew Gentner, Rachel O'Brien, Andrew Ault, *University of Michigan*

Acidity is an important property of atmospheric aerosols that influences multiphase reactions, secondary organic aerosol (SOA) formation, and particle physicochemical properties. Ammonia-ammonium partitioning plays a crucial role in determining aerosol pH, but combined ambient measurements of this base-conjugate acid pair, which contributes to a range of aerosol types within a diverse particle population, have been limited. Urban ammonia emissions are especially challenging to measure due to its low ambient concentrations, high solubility in water, and interference from other species in the gaseous matrix. Here, we compare high time resolution ammonia measurements from a cavity ring-down spectrometer during the New York City-metropolitan Measurements of Emissions and TransformationS/Atmospheric Emissions and Reactions Observed from Megacities to Marine Areas (NYC-METS/AEROMMA) field campaign in July-August 2023 with ambient single-particle composition from a range of microspectroscopy measurements, including simultaneous optical-photothermal infrared (O-PTIR) and Raman microspectroscopy. By examining the ammonia time series in the context of single-particle and bulk ammonium measurements from Aerosol Chemical Speciation Monitoring (ACSM), we evaluate ammonia/ammonium equilibrium and the range of aerosol pH across a heterogeneous particle population. pH measurements are also compared with controlled laboratory measurements of atomized ammonium sulfate at different acidities to gain further insight into the field data. These results provide an improved framework for understanding the distribution of aerosol pH in an urban area and have the potential to help improve atmospheric models by accounting for aerosol acidity impacts.

2AC.23

Local and Regional Influences on Aerosol Composition at two Coastal Sites during EPCAPE. SANGHEE HAN, Abigail Williams, Veronica Berta, Jeramy Dedrick, Christian Pelayo, Nattamon (Jeep) Maneenoi, Atsushi Osawa, Maria Zawadowicz, Arthur J. Sedlacek, Lynn M. Russell, *Scripps/UCSD*

In coastal areas, aerosol composition is influenced by both local and regional emissions, with variations depending on meteorological conditions. The Eastern Pacific Cloud Aerosol Precipitation Experiment (EPCAPE) characterized aerosol composition in a coastal area using measurements at Scripps Pier (300 m Offshore and 18 m ASL) and inland at Mt. Soledad (3 km downwind and 250m ASL). This study compares the aerosol composition, focusing on the refractory black carbon (rBC) measured by Single Particle Soot Photometer (SP2), and non-refractory (NR) aerosol composition measured by high-resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS) or aerosol chemical speciation monitor (ACSM) at each site. The hourly averaged mass concentrations of rBC and NR aerosol compositions at Mt. Soledad moderately correlate to those measured at Scripps Pier (r=0.64-0.74). The seasonal patterns and magnitudes of chemical mass concentrations were similar at both sites, indicating a consistency in aerosol sources. During summer, low concentrations of rBC, NR-organics, and NR-NO_3 were observed for air masses transported from the coastal northwesterly region (about 80% of the time). However, when the air masses originated from the Santa Ana or southerly directions, concentrations of rBC were up to 2.5 times higher, NR-organics were 1.3 times higher, and NR-NO_3 were 1.5 times higher at both sites, bringing higher concentrations from inland San Diego. During coastal northwesterly trajectories, the concentrations of rBC, NR-organics, and NR-NO_3 at Mt. Soledad were significantly higher ($p < 0.05$) than at Scripps Pier, likely attributed to the local impact on aerosol composition at Mt. Soledad under constant and strong sea breeze. These analyses quantify the local differences in concentrations that constrain aerosol composition and their sources in this coastal region.

2AC.24

Investigating Particle-Phase Chemistry between Products of Oxidation of α-Pinene and Phenol. SIJIA LIU, Celia Faiola, Sergey Nizkorodov, *University of California, Irvine*

Understanding the chemical composition and aging of secondary organic aerosols (SOA) is crucial for predicting their impact on climate change. In this study, we investigate the particle-phase reactions between SOA compounds derived from the OH oxidation of α-pinene and phenol. The two types of SOA were generated separately in a batch mode smog chamber, collected on the same substrate, and subsequently allowed to mix and react under different humidity conditions. High-Performance Liquid Chromatography coupled with Electrospray Ionization High-Resolution Mass Spectrometry (UHPLC-ESI-HRMS) was used to elucidate compositional changes, with particular attention to the compounds only found in the mixed aerosol. We hypothesize that the chemical reactions between compounds that belong to distinct SOA types will lead to enhanced chemical complexity of the mixed SOA, including the formation of unique oligomeric compounds and other particle-phase reactions, potentially resulting in altered physicochemical properties such as increased viscosity and modified volatility.

2AP.1

Black Carbon Optical Properties in El Paso Airshed. JOSCELYNE GUZMAN - GONZALEZ, Fatema Tuz Zohora, Rosa M. Fitzgerald, Laura Fierce, Payton Beeler, *University of Texas at El Paso*

Abstract: Black carbon is a ubiquitous component of atmospheric particles that affects human health, disrupts ecosystems, and controls local and global climate. The El Paso, TX– Juarez, Mexico metropolis is one of the biggest in the country. With heavy traffic on the international bridges between the cities of El Paso and Juarez, the PM2.5 concentrations keep increasing in this airshed. In a previous study, the optical properties of black and brown carbon in the El Paso–Juárez airshed were examined by our research group. In this innovative study we will focus on the difference of optical properties of black carbon in the presence and absence of coating. To achieve this, we will be utilizing a Photoacoustic extinctiometer (PAX), a thermal denuder and available carbon optical data from local monitoring stations. We will collect data utilizing the PAX at 870 nm wavelength to obtain the optical measurements of black carbon with coating and, upon using a denuder, the measurements without the coating. Inter-comparisons of the optical measurements obtained against Mie extinction calculations with and without the carbon coating will be presented. This study will be the first to be conducted in this area.

2AP.2

Exploring Temperature Dependence on Optical Properties: Data to Inform Exoplanet Modeling. JACOPO TERRAGNI, Erika Kohler, Vincent Kofman, *NASA Goddard Space Flight Center*

Recent observations from James Webb Space Telescope (JWST) are advancing our understanding of exoplanet atmosphere composition, dynamics, structure, and formation processes. However, extracting valuable information from observations is not straightforward: atmospheric models need to be superimposed onto the acquired spectra to translate these observations into the physical and chemical features of the planet. Unfortunately, models are limited because of the lack of in situ laboratory data collected at conditions like the ones observed on exoplanets, and new laboratory data are desperately needed as parameters to advance state-of-the-art exoplanet atmospheric models. In particular, the optical properties of the variety of different atmospheric particles expected in extrasolar systems are still largely unknown, especially at high temperatures that can be found in exoplanetary atmospheres. Despite the accuracy of the current and future observations, this fact fundamentally limits the characterization of observed exoplanets. Our project aims to address this lack of data by providing optical properties measurements of a diverse variety of particles, at temperatures representative of exoplanets observations, and make them available for the exoplanet scientific community. This project is carried out at the Hot Environments Lab at NASA GSFC and the experimental apparatus for this spectroscopic study consists of a High Temperature High Pressure (HTHP) Cell integrated into an FTIR (Fourier Transform InfraRed) spectrometer. Here we present the dedicated sample preparation procedure, how transmission spectra are collected, and how the optical properties of these particles are retrieved from the acquired spectra via a Lorentzian dispersion method. Finally, we discuss our plans to integrate these data into the Planetary Spectrum Generator (PSG) optical data library to quantitatively explore the differences between spectra retrieved by using room temperature optical data compared with the high temperature data collected in this project.

2AP.3

Optical properties of Aluminum Oxide Aerosols: A Candidate for Stratospheric Aerosol Injection. TAVEEN KAPOOR, Prabhav Upadhyay, Benjamin Sumlin, Dhruv Mitroo, Guodong Ren, Rohan Mishra, Rajan K. Chakrabarty, *Washington University in St. Louis*

Stratospheric aerosol injection (SAI) is a proposed geoengineering technique to counteract the rising global temperature by injecting sunlight-reflecting particles into the stratosphere. The ideal SAI particles should not absorb ultraviolet-visible-infrared radiation and should efficiently backscatter incoming solar near-UV-visible radiation. Recent studies have highlighted the advantages of solid aerosol particles (over sulfate aerosols) for SAI because of their theoretically high backscatter ratios and negligible absorption. However, crystal defects in the materials may lead to non-trivial absorption, hence, there is a need to study the optical properties of industrially generated candidate solid aerosol particles. This study presents the optical properties of aluminum oxide (Al_2O_3), a candidate SAI material potentially exhibiting the desired optical properties. We generated nanometer-size Al_2O_3 particles using a bench-scale powder dispersion system and measured their optical and morphological properties. We use custom-built single-pass single-wavelength (375, 405, 532, 721, and 1047 nm) Integrated-Photoacoustic-Nephelometers, a dual-cell multi-wavelength (405, 488, 561, and 637 nm) IPN (mIPN), and an integrating nephelometer with backscatter shutter to measure real-time, spectrally varying absorption, scattering, and backscattering coefficients. A scanning mobility particle sizer and an aerodynamic aerosol classifier were used to calculate the electrical mobility and aerodynamic diameters, respectively. Aerosol particles were collected on lacey carbon grids for transmission electron microscopy. Electron microscopy images showed irregularly shaped particles, which will be used to estimate shape factors determining their backscatter fractions. The collected particles will also be used to estimate particle-scale complex refractive indices using electron energy loss spectroscopy. The findings from the present study will provide fundamental information on the optical properties of aluminum oxide particles which will are necessary for radiative forcing calculations and climate model simulations to assess the viability of SAI using Al_2O_3.

2AP.4

Spectral Light Absorption in Aerosol Emissions from Anthropogenic Biomass Burning in India. Chimurkar Navinya, Taveen Kapoor, CHANDRA VENKATARAMAN, Gupta Anurag, Harish C Phuleria, Rajan K. Chakrabarty, *Indian Institute of Technology Bombay*

Short lived climate forcers include carbonaceous aerosols (black carbon-BC and organic aerosol-OA) which perturb Earth’s radiation balance and drive climate change. There is growing evidence supporting the relevance of light absorbing organic carbon, termed brown carbon (BrC), to climate change, but gaps in understanding optical properties of BrC hinder its representation in climate models. In India, atmospheric measurements have established significant BrC absorption, possibly related to the prevalence of biomass burning for energy and waste disposal, pointing to the need to better understand emission aerosols.

Here we studied spectral optical properties of emission aerosol samples from different types of anthropogenic biomass burning activities in India, including residential cooking and heating, brick manufacture and agricultural residue burning, using field measurements made during the COALESCE (Venkataraman et al. 2020) campaign. Spectral absorption of methanol extracts of the organic carbon fraction of filter collected particles, was estimated from spectrophotometer measurements, made between 300 nm to 900 nm, with absorption normalization to limit signal drift. Thermally resolved carbon fractions were concurrently measured using thermal optical reflectance. The spectral absorption of BrC was used to derive the mass absorption cross-section (MAC_{BrC}), imaginary refractive index ($k_{BrC,550}$) and its spectral dependence (w).

We find significantly large values of BrC absorption and the imaginary refractive index in the extracts. A regression-based relationship to the BC/OA revealed $k_{BrC,550}$ values increasing from ~0.006 to 0.74, and w decreasing from 5.24 to ~0 across a range in BC/OA ratio of 0 to 20, showing behavior consistent across the black-brown carbon light absorption continuum. An imaginary refractive index ~2-3 times larger than that in previous studies, indicates strong absorption. Combining this with an emissions inventory over India, the paper will discuss spatial patterns in BrC absorption over India and implications for its influence on regional climate.

[1] Venkataraman, C., M. Bhushan, S. Dey, D. Ganguly, T. Gupta, G. Habib, A. Kesarkar, H. Phuleria, R. Sunder Raman (2020) Indian network project on Carbonaceous Aerosol Emissions, Source Apportionment and Climate Impacts (COALESCE), Bull. Am. Met. Soc., https://doi.org/10.1175/BAMS-D-19-0030.1

2AP.5

Modelling the Frequency Dependency of the Photothermal Signal From Single Aerosol Particles at Low Relative Humidity. FELIX STOLLBERGER, Alexander Bergmann, *Graz University of Technology*

Photoacoustic spectroscopy (PAS) and photothermal interferometry (PTI) are two closely related experimental techniques used to probe the optical and physicochemical properties of aerosol particles. Along with numerous experimental studies, the modeling of PAS has evolved significantly from energy-balance models over complex, fully analytical approaches solving the Naiver-Stokes equations to recent multilayer heat and mass-transfer models. In general, the simulations show that the excitation frequency dependency of the photoacoustic signal contains information about evaporation-condensation and thermal equilibrium effects. However, this dependency has not been further investigated, as it is not experimentally accessible with PAS.

PTI allows to investigate this effect for the first time experimentally on single particles. However, theoretical models capable of simulating the measured size and frequency-resolved photothermal signal are currently unavailable. Therefore, we present a novel semi-analytical model combining the advances in photoacoustic modeling with the detection mechanism used in PTI.

In our model, we use the existing framework of PAS to compute the temperature of a single, isolated particle exposed to a sinusoidally modulated excitation laser in a dry environment. The heat flux from the droplet is used as a boundary condition to solve the heat equation for radially-symmetric outgoing thermal waves. Evaluating the amplitude and phase of the thermal wave in terms of a refractive index shift allows to determine a local optical path-length difference (δOPL), affecting the phase of the interferometer beam. Integrating δOPL over the intensity-weighted volume of the probe beam yields the experimentally accessible photothermal amplitude (PTA) and phase (PTP).

We validated our model with experimental data, indicating a good agreement of the PTA and PTP for frequencies lower than 6kHz in the investigated size range of 1.5–4.5µm. A systematic, radius-dependent phase shift was observed for frequencies higher than 10kHz, which could be linked to the so far excluded mass flux from the particle.

Overall, we successfully proved the validity of our model for, highlighting its future applicability to retrieving optical or thermodynamic properties of single aerosol particles by fitting experimental data with the presented theoretical model.

2AP.6

Dark Brown Carbon Snow Darkening Effect: An Experimental Validation. GANESH CHELLUBOYINA, Taveen Kapoor, Rajan K. Chakrabarty, *Washington University in St. Louis*

Smoke from frequent wildfire events continues to pose serious climatic challenges. One of these challenges is the eventual settling of some wildfire smoke particles in the cryosphere, causing the snow darkening effect and contributing to the albedo climate feedback. Of all the light absorbing constituents of wildfire smoke, strongly absorbing dark brown carbon (d–BrC) has been the least studied, as it only has recently been identified in laboratory studies and observed in a field campaign. Most studies prior to this one have focused on snow albedo reduction and radiative forcing impacts due to black carbon (BC) or water-soluble organic carbon originating from smoldering combustion. Our work aims to bridge the gap in the understanding of d–BrC induced snow radiative forcing through aerosol deposition experiments. Through a purpose-built chamber cooled by liquid nitrogen, we rapidly froze a mist spray and accumulated ice grains to create artificial snow. D–BrC particles generated through the dry distillation of wood were deposited on this snow. Reflectances of the snow samples were measured using an integrating sphere. Aerosol optical properties and concentrations, and the snow grain size were key tunable parameters, and we observed their impact on the snow albedo. Using this experimental data, we compared and validated our Snow, Ice, and Aerosol Radiative (SNICAR) model-based albedo predictions. We also present measurements related to the evolution of the aerosol size distribution in snow. Finally, we examine the influence of the aerosol deposition mode, whether wet deposited (along with precipitation) or dry deposited (continuous deposition flux from the atmosphere), on aerosol-snow mixing state and thereby albedo by varying the experimental conditions. These results will amplify our understanding of the wildfire snow darkening effect and the aftereffects thereof.

2AP.7

Stratospheric Aerosol Injection: An Engineering Review.

MIRANDA HACK, Gernot Wagner, Dan Steingart, V. Faye McNeill, *Columbia University*

Stratospheric aerosol injection (SAI) has been proposed for purposes of climate mitigation via solar radiation management. We recently reviewed potential environmental and climate impacts of SAI (Huynh and McNeill 2024). A variety of materials and injection strategies have been proposed, but these studies mainly rely on climate models with minimal consideration of technical, logistical, or economic feasibility. Those that do have focused primarily on sulfate aerosol, but solid aerosol candidates have also been proposed due to their desirable optical properties and heterogeneous reactivity relative to sulfate. Here, we take an engineering approach to analyze the feasibility of several SAI strategies, organized by particle type and injection pattern.

Along with optical properties, the efficacy of an SAI material is strongly linked to particle number size distribution (PNSD). We address several technical challenges in producing and dispersing aerosol candidates in the desired sub-micron PNSDs. The logistical and financial feasibility of using solid aerosol materials, liquid H_2SO_4, or sulfate formed via SO_2 (g) is assessed using both the current state of achievable PNSDs and the optimal scenario.

Injection strategy is another key driver of SAI outcomes. Reynolds and Wagner (2019) described a decentralized SAI model executed with many SO_2-filled balloons, an approach which has been pursued commercially. However, timing, latitude and altitude of injections play key roles in PNSDs and SAI's impact on climate feedback mechanisms like the quasi-biennial oscillation and intertropical convergence zone. This decentralized scenario has not been simulated in global climate models, but compiling the results of several studies on injection strategy allows us to infer that decentralized action may result in suboptimal SAI outcomes, particularly when considering geopolitical factors that may limit these climate actors to the Global North. Practical considerations, including lifting gas availability and plastic waste generation, may also limit the feasibility of this decentralized model.

2AP.8

Measuring Complex Particulate Refractive Index Spectra.

CHRISTOPHER M. SORENSEN, Prakash Gautam, Sami Labidi, Justin Maughan, Kurt Ehlers, Hans Moosmüller, *Kansas State University*

We present a method to measure the real and imaginary parts of refractive indices of ensembles of particles. The foundation of this method is to suspend the particles in media of a variety of refractive indices and measure the spectral light scattering from and extinction through the suspension. When the real part of the particle refractive index is matched by the medium refractive index, both the scattering and extinction coefficients will pass through a minimum. This yields the real part of the particle refractive index spectra. The imaginary refractive index can then be obtained for a number of different situations as: (1) for particles small compared to the optical wavelength via Rayleigh scattering and extinction ratios, (2) for fractal aggregates of arbitrary size using the Rayleigh-Debye-Gans formalism when it holds, (3) for spherical particles using Mie theory, and (4) with less accuracy for particles of arbitrary size and shape, using modern scattering/extinction codes. If the real part of the refractive index for liquid media is not large enough (cost effective liquids go to n = 1.62, expensive ones to 1.87), extrapolations techniques may be viable for the Rayleigh regime and for spherical particles.

2AP.9

Finite Element-Based Extended Kalman Filter and Smoother for Retrieval of Aerosol Size Distributions and Process Rates. TEEMU SALMINEN, Kari E.J. Lehtinen, Matti Niskanen, Pietari Mönkkönen, Jari P. Kaipio, Aku Seppänen, *University of Eastern Finland*

Aerosol particles have a major effect on the climate as they reflect and absorb incoming solar radiation and act as cloud condensing nuclei, indirectly affecting the albedo of the Earth. However, these effects are highly uncertain due to uncertainties in aerosol dynamics modeling in global climate models as both aerosol process rate approximations and applied aerosol dynamics models are typically rather crude.

Temporal evolution of the aerosol number distribution can be described with the General Dynamic Equation of aerosols (GDE) which is an integro-partial differential equation that accounts for processes affecting an aerosol particle population. However, the process rates (growth rate, deposition rate, and nucleation rate) and mechanics behind them are partially unknown. To approximate the evolution of aerosol number distributions accurately with GDE, these process rates should be approximated accurately.

Extended Kalman filter (EKF) and Fixed interval Kalman smoother (FIKS) are powerful statistical tools which can be used to estimate variables and their uncertainties from the sequential measurements in the Bayesian state-space framework. We apply the EKF and FIKS, which uses Finite Element Method (FEM) approximation of GDE in prediction step, to estimate the temporal evolution of aerosol size distribution and process rates and their variances in simulated case and for a chamber measurement. We investigate whether the EKF and FIKS lead to more accurate process rate estimates than customarily applied ones.

Our preliminary results indicate that FEM- based EKF and FIKS provide feasible estimates for the aerosol number distribution and aerosol process rates in both cases. Moreover, we obtain approximations for uncertainties of our estimates. Future goal is to apply the methodology to atmospheric aerosol data to obtain estimates for the process rates with uncertainties which then can be used in the climate model parametrizations after the feasibility of methodology is established.

2AP.10

Volume Additivity of Nanoscale Aerosol Mixtures. SAMANTHA LI, Sarah Petters, *University of California, Riverside*

Nanosized aerosols are subject to elevated internal pressure that can influence reaction rates, reaction mechanisms, and the viscosity of organic aerosols. Accurate models of interlinked physicochemical properties are essential for understanding and predicting aerosol formation and growth. Although results have shown that factors such as constriction, irregularity, or excess volume of mixing can introduce errors in particle diameter measurements, particle density estimates remain crude, and conservation of density is typically assumed. In this work, we present a multidimensional framework for predicting the role of surface tension and changing partial molar volume on aerosol uptake and growth processes. We incorporated measurements and interpolated datasets from chemical oceanography and atmospheric chemical thermodynamics and track mixing energy and growth-factor-dependent partial molar volumes. Activity models including an empirical model of thermochemical properties of seawater and the Extended Aerosol Inorganics Model (E-AIM) were used to determine energy of mixing. The Laplace equation was used to estimate internal pressure based on surface tension and water uptake. The compressibility of pseudo-binary aqueous mixtures was found to be dependent on the composition. We discuss recommendations for mass- and diameter-based metrics of particle growth. Results also vary as a function of the composition-dependent surface tension and composition-dependent particle growth by hygroscopic water uptake.

2BA.1

Evaluation of a Novel Bioaerosol Collection System against Standard Bioaerosol Samplers. AMANDA WEILER, Nora Chan, Nathalie Turgeon, Caroline Duchaine, Loïc Coudron, Ian Johnston, Timothy Foat, *Defence Research and Development Canada*

Early detection of biological threats is essential to strategic preparedness and response. This project aimed to assess the collection efficiency of a novel bioaerosol collection and concentrating system based on electrostatic precipitation and electrowetting on dielectric (ESP-EWOD). A bioaerosol chamber trial was conducted to compare the ESP-EWOD system against two standard bioaerosol samplers: an SKC BioSampler® and a 37 mm filter cassette containing a 0.8 µm polycarbonate filter. Three bacteria (*Bacillus atrophaeus* spores, *Pantoea agglomerans*, and *Escherichia coli*) were aerosolized into a chamber so that all three samplers could collect simultaneously. The samples were eluted for analysis by culture, endotoxin assay, and quantitative polymerase chain reaction (qPCR). The comparison between samplers showed that the ESP-EWOD has similar collection and elution efficiencies to the SKC BioSampler® and filter cassette for *P. agglomerans* and *E. coli*, but elution efficiency was lower when collecting *B. atrophaeus* spores. The concentrations of ESP-EWOD samples were much higher compared to samples collected with the SKC BioSampler® (1000x higher for *P. agglomerans* and *E. coli* and 33x higher for *B. atrophaeus*). Continued work with the ESP-EWOD will enhance the system’s capabilities and provide a comprehensive assessment of the efficiency, reliability, and usability of this novel bioaerosol collection system in diverse environments. This first of a series of planned trials showed that the ESP-EWOD is a promising technology for integration into a low burden bioaerosol detection system. Additional work will be done to optimize the collection and elution processes, test the system in other aerosol chambers and complex field environments, and integrate the system onto uncrewed vehicles for remote collection.

2BA.2

Exploring Pig Finishing Buildings and Broiler Chicken Barns Contribution to Outdoor Airborne Microbiota and Antibiotic-Resistance Genes. JOANIE LEMIEUX, Marc Veillette, Cindy Dumais, Valérie Létourneau, Nathalie Turgeon, Caroline Duchaine, *Université Laval*

Introduction. Confined animal feeding operations (CAFOs) are significant emitters of bioaerosols. Indoor air studies are often conducted in CAFOs to quantify, measure exposure or characterize specific air quality markers, mostly from an occupational or an animal health perspective. Bioaerosols can contain microorganisms and antibiotic-resistance genes (ARGs). Through the ventilation systems, a proportion of indoor bioaerosols are disseminated outside the barns where their fate around the buildings vicinity is not well understood.

Objectives. 1) Characterize bacterial and ARGs diversity and 2) quantify specific microbial markers emitted from two conventional pig finishing buildings (PFB) and broiler chicken barns (BCB) within 1km radius from the buildings.

Methods. Bioaerosols were collected using the SASS® 3100 Dry Air Sampler and SASS® 4100 Two-Stage Aerosol Collector. Samples were taken indoor, at the fan exhaust and at four different outdoor locations depending on the prevailing winds: 10m, 100m, 1km downwind and 1km upwind. PFB and BCB were visited three times during the warm season. DNA was extracted from filters and used for performing amplicon-based sequencing to describe bacterial diversity and to quantify by PCR: ARGs, bacterial and archaeal 16S rRNA genes, *Enterococcus* spp., a phage of *Aerococcus viridans* and swine and poultry DNA.

Results. Total airborne bacterial biomass (16S rRNA gene) and the other microbial markers decrease with distance from the CAFOs. The same pattern is observed when looking at the sum of all (37) ARGs. At 1km downwind, some markers (*Enterococcus* spp. and ARGs (*erm35*)) are still detectable. Bacterial core is similar from indoor to 1km locations. However, relative bacterial abundances exhibit greater dissimilarity at 1km distances compared to the other locations.

Conclusion. Even at 1km downwind, it is possible to detect airborne microbial markers and ARGs likely emitted from CAFOs and recover a similar bacterial core indoors.

2BA.3

Comparing Two Novel Passive Sampling Methods to Characterize Bioaerosols Emissions From Agricultural Activities: Rutgers Electrostatic Passive Sampler (REPS) and Conifer Needles.

SAMANTHA LECLERC, Gediminas Mainelis, Nathalie Turgeon, Florent Rossi, Kevin Dillon, Paul George, Marc Veillette, Caroline Duchaine, *Université Laval*

Background:
The REPS uses a polarized ferroelectric polymer film in a spiral configuration to capture charged bioaerosols, standing as a complementary technique to active air samplers. Conifers and, specifically, their needles bioaccumulate antibiotic resistance genes (ARGs) and can also be used for passive sampling. Thus, this project used these two passive sampling approaches to characterize bioaerosols emitted from agricultural activities and compare their performance to active air sampling methodologies for bioaerosol monitoring during continuous emissions from a swine barn and manure spreading activity.

Procedure:
For the barn emissions, air was collected 5 meters from the fan exhausts using a SASS active sampler. The REPS were placed near the closest spruce edges (10m) for 2 weeks. The experiment was repeated 4 times, and needles (15g) were systematically sampled. For manure spreading, the air was collected using both SASS and REPS samplers by following a spreader with a tractor. Additional air samples were collected near a cedar hedge, along with needles (15g). The experiment was repeated 5 times. DNA was extracted from samples and the concentrations of total bacteria (16S rRNA gene), pig indicators (an *Aerococcus viridans* phage and pig DNA) and 28 ARGs were assessed by qPCR/high-throughput qPCR. Results were compared to the bioaerosols at controls sites located six kilometers away from any agricultural influence.

Findings:
All samplers managed to capture airborne bacteria and the *A. viridans* phage with comparable efficiencies. However, pig DNA tended to be lower on the REPS than SASS and needles. All samplers showed similar ARG patterns. Overall, passive samplers, REPS and conifer needles, appeared to be more suitable for assessing continuous emissions than short-term emission events.

Implications:
The passive samplers displayed a strong potential to monitor bioaerosols emissions from agricultural facilities. Their efficiency to estimate emissions from other facilities, including poultry barns, will be evaluated.

2BA.4

Development and Validation of a Large-Scale Controlled Aerosol Chamber to Evaluate Air Purifier Efficiency Against Live Viral Aerosols.

VINCENT BROCHU, Marc Veillette, Nathalie Turgeon, Gregory Nilsson, Liang (Grace) Zhou, Caroline Duchaine, *Université Laval*

Introduction
During the COVID-19 pandemic, air purifying devices were utilized to clear airborne viral aerosols in multi-occupancy spaces such as hospital wards, classrooms, conference rooms, etc. While these devices are typically tested in confined spaces against various particulate matter such as smoke, dust, and pollen, their efficiency in the inactivation and removal of viral aerosols has not been adequately assessed. This study aims to develop a method for evaluating the efficacy of air purifier specifically against viral particles.

Procedure
MS2 bacteriophage was aerosolized within a 10 m^3 aerosol chamber with controlled air exchange rate using a Collison 6-jet nebulizer. Viruses were sampled directly onto Tryptic Soy Broth Petri Dishes previously inoculated with MS2’s host strain using two Slit-to-Agar devices, positioned in the middle of the chamber. Following sampling, Petri dishes were incubated overnight (37°C). Additionally, particles were counted using an Aerodynamic Particle Sizer (APS). Air exchange rates per hour were calculated from the concentration decays measured by the APS and by culture methods adhering to the ASTM-E741 standard. Air exchange rates were compared with and without the use of the air purifier to assess its efficiency and the validity of the method.

Results and Discussion
The viral decay and measured air exchange rate were consistent with the use of the settings of the air purifier (off, 50%). The time resolution of the two Slit-to-Agar devices indicates homogeneous air mixing within the chamber. However, viral decay did not mirror particle decay patterns, as air exchange rates calculated based on particle concentrations often exceeded those based on viruses decays. Computational Fluid Dynamics (CFD) modeling will be employed to describe air movements within the chamber, and additional types of air purifiers will be tested.

Funding
This project is funded by the National Research Council of Canada.

2BA.5

Prevalence and Seasonal Variations of Salmonella, STEC, and L. monocytogenes in the Air and Surface at a Meat Processing Plant.

MEIYI ZHANG, Maria King, *Texas A&M University*

Foodborne diseases can have far-reaching impacts on economies, exerting significant financial burdens on the healthcare systems and the food industry. Meat processing plants handle large volumes of raw meat, making them susceptible to bacterial contamination during various stages of production. In beef processing plants, the majority of harmful bacteria are introduced by the beef carcasses, which may become aerosolized and entrained in the air to travel long distances, increasing the risks of contamination of meat products. In this study, air and surface samples were collected from various locations in a meat processing plant during different seasons – winter, spring, and summer – and analyzed using quantitative Polymerase Chain Reaction (qPCR) for the counts of total bacteria, *Salmonella*, Shiga toxin producing *Escherichia coli* (STEC), and *Listeria monocytogenes* (*L. monocytogenes*) due to their high prevalence in meat products and severe health consequences. The presence of the SARS-CoV-2 virus in the samples was also studied as some workers reported COVID-19 incidences during the time of collection. Metagenomics analysis was performed on selected environmental samples to study the genetic composition of the microbial communities. Critical locations and area in the meat processing plant were identified based on the concentrations of the bacteria in the samples and compared for seasonal variations.

2BA.7

Understanding the Impacts of Convective Storms on Bioaerosols in a Grassland Environment.

TERESA FELDMAN, Janeshta Fernando, Chamari Mampage, Claudia Mignani, Marina Nieto-Caballero, Thomas C. J. Hill, Brian Heffernan, Drew Juergensen, Christine Neumaier, Tyler Barbero, Charles Davis, Lexi Sherman, Ben Ascher, Jacob Escobedo, Nick Falk, Sean Freeman, Gabrielle Leung, Allie Mazurek, Daniel Veloso-Aguila, Leah Grant, Susan van den Heever, Russell Perkins, Paul DeMott, Sonia Kreidenweis, Elizabeth Stone, *University of Iowa*

Bioaerosol can be transported, emitted, and transformed in thunderstorms, and may alter cloud microphysics as cloud condensation and ice nuclei. To investigate dynamics between bioaerosol and convective storms, bioaerosol were characterized in a grassland environment in the BioAerosol and Convective Storms (BACS) field campaigns in 2022 and 2023. Storms were evaluated in Northern Colorado using drones and radiosondes, fluorescent particles were measured by single particle fluorescence spectroscopy as a proxy for bioaerosols, and aerosol samples were collected for offline analysis. Precipitation events typically increased concentrations of fluorescent particles by at least 2x. Cold pools, which consist of denser, cooler, and sometimes more humid air than its environment, and form and expand under thunderstorms, triggered varying bioaerosol responses. On June 8, 2023, two cold pools and rainfall occurred over three hours, with peak fluorescent particle number concentrations relative to background increasing by 5x during the first cold pool, 15x during precipitation, and 5x during the second cold pool. The cold pools increased sub- and supermicron fluorescent particles associated with bacteria and fungal spores, while rainfall increased supermicron fluorescence types associated with fungal spores. Offline aerosol measurements of a fungal spore tracer (mannitol) concurrently increased. On June 2, 2023, three cold pools occurred over seven hours with no rainfall, with concentrations increasing by 2x during the first cold pool, decreasing by 1.5x for the second, and decreasing by 5x for the third. The first cold pool increased submicron types associated with bacteria, while the second and third primarily decreased supermicron fluorescent particles associated with fungal spores. Differences in fluorescent particle responses seem to be meteorologically driven, with increased concentrations during cold pools often being associated with stronger wind gusts and temperature perturbations. Future analysis will examine the role of these bioaerosols as ice nucleating particles and their potential feedbacks on thunderstorms.

2BA.8

Dynamic Patterns and Health Implications of Bioaerosols in Qatar's Arid Climate: A Year-Long Observational Study. AZHAR SIDDIQUE, Kashif Rasool, Bilal Sajjad, Khadeeja Abdul Jabbar, Shimaa S. El-Malah, M. Rami Alfarra, Fares A.O Almomani, *QEERI, Hamad Bin Khalifa University, Doha, Qatar*

Exploring the complex dynamics of bioaerosols within arid climates, this observational study delves into the microbial composition and seasonal variability of airborne pathogens in Qatar. Utilizing a Coriolis® µ sampler across ten strategically selected sites, the research captures a full year of data spanning from November 2021 to September 2022. Our analysis reveals pronounced seasonal fluctuations in microbial concentrations, with peak bacterial levels observed during the summer and maximum fungal densities during the winter. This study not only highlights significant variations in bioaerosol loads but also uncovers robust antibiotic resistance, particularly to Metronidazole, during the hot season. These findings are critical for developing targeted public health strategies and enhancing environmental monitoring frameworks in regions facing similar arid conditions.

2BA.9

Occupational Exposure Monitoring of Airborne Respiratory Viruses in Outpatient Medical Clinics. William B. Vass, AMIN SHIRKHANI, Mohammad Washeem, Sripriya Nannu Shankar, Yuetong Zhang, Tracey Moquin, Rebeccah Messcher, Matthew D. Jansen, James R Clugston, Matthew Walser, Yang Yang, John Lednicky, Z. Hugh Fan, Chang Yu Wu, *University of Florida*

Exposure to airborne respiratory viruses can be a health hazard in occupational settings. In this study, air sampling was conducted from January to March 2023 in two outpatient medical clinics—one primary care clinic and one clinic dedicated to the diagnosis and treatment of respiratory illnesses—for the purpose of measuring airborne respiratory virus presence. Work involved the operation of a BioSpot-VIVAS^{TM} as a stationary air sampler and deployment of NIOSH BC-251 bioaerosol samplers as either stationary devices or personal air samplers worn by staff members. Results were correlated with deidentified clinical data from patient testing. Samples from seven days were analyzed for SARS-CoV-2, influenza A H1N1 and H3N2 viruses, and influenza B Victoria- and Yamagata-lineage viruses, with an overall 17.5% (17/97) positivity rate. Airborne viruses predominated in particles of aerodynamic diameters from 1-4 µm and were recovered in similar quantities from both clinics. BC-251 samplers (17.4%, 15/86) and VIVAS (18.2%, 2/11) collected detectable viruses at similar rates, but more numerous BC-251 samplers provided greater insight into virus presence across clinical spaces and job categories. 60% of samples from reception areas contained detectable virus, and exposure to significantly more virus ($p = 0.0028$) occurred at reception desks as compared to the “mobile” job categories of medical providers and nurses. Overall, this study provides valuable insights into the impacts of hazard mitigation controls tailored to reducing respiratory virus exposure and highlights the need for continued diligence toward exposure risk mitigation in outpatient medical clinics.

2BA.10

Using Tryptophan as an Indicator of pH in Bioaerosol Particle Fluorescence. HUNTER RICHARDS, Emily Hong, Zhenyu Ma, Allen E. Haddrell, Herek L. Clack, *University of Michigan*

Introduction

While the role of pH in respiratory virus inactivation has recently been discussed [1], measuring the change in pH of aerosols carried in exhaled breath is required to better define this relationship. To better understand the potential effect that an increase or decrease in pH has on the inactivation of certain respiratory viruses, it is first necessary to characterize the change in pH of a bioaerosol over time. Common fluorophores found in bioaerosol particles such as amino acids like tryptophan [2] can be exploited to interrogate pH change in exhaled bioaerosols that are relevant to the transmission of infectious disease. In previous experiments, it was determined that a higher pH correlates with a higher fluorescence intensity for tryptophan. Using tryptophan as a pH-dependent fluorophore, it is possible to model the change in pH of bioaerosols.

In this study, a wideband integrated bioaerosol sensor (WIBS) is used to analyze the fluorescence intensity of aerosolized solution within a closed chamber as the CO_2 concentration rises, using tryptophan as a fluorophore to track pH.

Experimental Procedure

A solution of 5% mass fraction of solute (MFS) NaCl and $NaHCO_3$ with tryptophan was aerosolized using a handheld nebulizer (Mesh Nebulizer Model YM-3R9) into a closed chamber at an aerosolization rate of approximately 1 mL per minute for 2 minutes. Using a CO_2 sensor (SAF Aranet4), the concentration of CO_2 was monitored within the chamber following aerosolization.

The WIBS instrument sampled from the chamber at a flow rate of 2.1 liters per minute for 10-20 second intervals over a 40 minute period. The WIBS instrument measured bioaerosol fluorescence intensity of the aerosols sampled from the chamber at predetermined time intervals by using a Xenon flash lamp to excite tryptophan at its known absorption wavelength of 280 nm, which produces fluorescent emission at 310-400 nm wavelength.

Results

The recorded fluorescence intensity spectra of sampled aerosols generated from bulk solutions of known pH are plotted in terms of relative abundance in Figure 1. The distinct spectra display substantial separation from the background noise (black spectra, Fig. 1), well beyond 5σ. At a higher bulk solution pH, aerosols generated from the NaCl + $NaHCO_3$ solution with added tryptophan exhibit a higher fluorescence intensity.

With the introduction to the chamber of the aerosolized NaCl + $NaHCO_3$ solution, the CO_2 concentration steadily rose. Pairing the temporal evolution of CO_2 concentration in the chamber with the time-resolved fluorescence intensity of aerosols sampled by the WIBS instrument, tryptophan fluorescence decreased as the CO_2 concentration increased. As pH is reduced, fluorescence intensity shifts to the left and decreases.

The color-coded spectra at indicated time points show a consistent reduction in fluorescence intensity of the solution with time and the increase in CO_2 concentration, suggesting the evolution of CO_2 from the aerosols is correlated with decreasing aerosol pH over time.

Summary and Conclusions

As CO_2 concentration increases over time, a reduction in fluorescence intensity was observed for the solution containing tryptophan as a fluorophore. This indicates a decrease in bioaerosol pH as CO_2 concentrations increase. Using WIBS to monitor fluorescence intensity of bioaerosols mimicking exhaled breaths paired with CO_2 concentration monitoring can help better understand the relationship between pH and virus inactivation.

References

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2BA.11

Concentrating Viable Airborne Pathogens Using a Multi-Nozzle Virtual Impactor Paired With a Compact Water-Based Condensation Air Sampler. William B. Vass, SRIPRIYA NANNU SHANKAR, John Lednicky, Morteza Alipanah, Braden Stump, Patricia Keady, Z. Hugh Fan, Chang-Yu Wu, *University of Florida*

People are constantly exposed to bioaerosols through the ambient air that they breathe. While there are several methods to collect and detect pathogens from the air, the infectivity of those agents must be assessed to fully evaluate health risks from exposure to airborne pathogens. Air samplers which operate by growing particles through water vapor condensation and subsequently collecting them into a liquid medium have proven effective at conserving the viability of microorganisms. We present a study that assessed the performance improvement of one such sampler, BioSpot-GEM^{TM}, gained by augmenting it with an upstream multi-nozzle virtual impactor (VI) designed to concentrate particles in aerosols. Two test organisms viz., *Escherichia coli* and human coronavirus OC43 were aerosolized using a Sparging Liquid Aerosol Generator and a 3-jet Bioaerosol Nebulizing Generator respectively, in custom-built laboratory air chambers. Post-collection, quantification by culturing methods showed the integrated air sampler (i.e., GEM_VI) improved the collection of live *E. coli* by a median Concentration Factor (CF) of 1.59 and increased the recovery of viable human coronavirus OC43 (OC43) by a median CF of 12.7 as compared to the sampler without the VI. A comparison between reverse transcription and quantitative polymerase chain reaction and culturing methods showed that OC43 can be concentrated by the integrated air sampler without significant loss of infectivity. Data analysis by Kruskal-Wallis rank sum tests indicated that no significant differences existed between the small BioSpot-GEM^{TM} and the larger BioSpot-VIVAS^{TM} for collection of live *E. coli* ($p > 0.05$), suggesting both the samplers had similar collection efficiencies. Our analyses show potential benefits toward improving the collection of viable pathogens from the air using a more portable water-based condensation air sampler, which can ultimately enable better characterization of health risks associated with airborne pathogen exposures.

2BA.12

Comparative Analysis of Wet and Dry Deposition of Bioaerosol Tracers. JANESHTA FERNANDO, Teresa Feldman, Chamari Mampage, Claudia Mignani, Marina Nieto-Caballero, Thomas C. J. Hill, Brian Heffernan, Drew Juergensen, Christine Neumaier, Tyler Barbero, Charles Davis, Lexi Sherman, Ben Ascher, Jacob Escobedo, Nick Falk, Sean Freeman, Gabrielle Leung, Allie Mazurek, Daniel Veloso-Aguila, Leah Grant, Susan van den Heever, Russell Perkins, Paul DeMott, Sonia Kreidenweis, Elizabeth Stone, *University of Iowa*

The BioAerosols and Convective Storms (BACS) field campaigns examine the exchange of bioaerosols between the terrestrial biosphere and atmosphere. The objective of this study is to evaluate bioaerosol dry and wet deposition, with the latter involving precipitation. Chemical tracer analysis provides insight to three classes of bioaerosols: fungal spores by mannitol; gram-negative bacteria by endotoxins; and pollen and plant matter by fructose, glucose, and sucrose. Samples were collected in the Central Plains Experimental Range in Northern Colorado from May-June of 2022 and 2023. The cumulative precipitation in 2022 was 10 mm occurring over five rain events (18% of study days). Over a 23-day period, the fungal spore wet deposition totaled 7.0×10^7 spores/m^2, which was 35 times higher than the estimated dry deposition of fungal spores (assuming a mean diameter 2.5 µm and unit density) and demonstrated the dominance of wet deposition over dry deposition. Comparison of rainwater concentrations to surface aerosol concentrations prior to rain revealed that surface aerosol concentrations accounted for less than 19% of the carbohydrates deposited in rainwater, indicating a significant enhancement of these compounds in aerosols or cloud water aloft. In the case of bacterial endotoxin, the magnitude of wet deposition was similar to the dry deposition, indicating the importance of both deposition processes. In 2023, precipitation totaled 119 mm over 21 rain events (60% of study days). In comparing across the two campaigns, the average wet deposition of pollen tracers was twice as high in the drier year, while the wet deposition of fungal spores was twice as high in the wetter year. This reflects the variability in atmospheric bioaerosol concentrations across these dry and wet years. This research provides insights into the magnitude and relative importance of wet and dry deposition for bioaerosol scavenging.

2BA.13

Hygroscopic Impact on Single Respiratory Bioaerosol Evaporation. AKHIL TEJA KAMBHAMPATI, Mark A. Hoffman, *Auburn University*

Analyzing the behavior of respiratory bioaerosols in air is crucial for elucidating the transmission dynamics of infectious diseases. This study focuses on the single bioaerosol behavior by examining the effects of salinity induced hygroscopic properties that mimic saliva-like behavior. To achieve this, pure water and saline doped droplets were monitored on an inverted microscope to measure the droplet size change rate. Hydrophobic slides were used to maintain a near-spherical shape, approximating the bioaerosol in the air. Experiments show that saline-induced hygroscopic behavior mitigates the rate of droplet size reduction. This deceleration in evaporation dynamics is critical for understanding the persistence and transmission potential of infectious bioaerosols. These findings provide essential airborne pathogen propagation mechanism insights and inform the development of effective airborne disease spread prevention strategies.

2BA.14

Measurement of Influenza Virus in Air Using a High-Enrichment, High-Flow Electrostatic Precipitator. JAEGIL LEE, Chanhwi Park, Jaesung Jang, *Ulsan National Institute of Science and Technology, Korea*

Since the 21st century, with the emergence of SARS (Severe Acute Respiratory Syndrome) and COVID-19 (Coronavirus Disease 2019), the incidence and spread of novel viral diseases transmitted through the air have been increasing in frequency. Consequently, there is a growing need for rapid detection technologies for airborne viruses to swiftly block the transmission of airborne viral diseases, prompting research into various collection devices. Among them, electrostatic precipitators are advantageous due to their high collection efficiency and high enrichment ratio, which allow for the detection of airborne viruses at low concentrations, regardless of particle size. However, they have the disadvantage of low collection flow rates, making them difficult to use in large areas.

This study introduces a particle concentration device (HEPC) using the electrostatic precipitation method, equipped with high concentration and collection flow rate to measure airborne viruses. To enhance collection efficiency at high flow rates, wire electrodes were installed above the collection electrode to strengthen the electric field intensity. As a result, more than 90% of influenza virus particles could be collected through a narrow electrode at 20 LPM. In fact, influenza viruses at inlet concentrations (10^4–10^5 gene copies/m^3), measured in the air of spaces with flu patients, were detected using 10-min sampling of HEPC and RT-qPCR.

2BA.15

Numerical Study on the Effect of Indoor Air Condition on Particle Growth in Water Condensation-Based Sampling Devices. WONYOUNG JEON, Junbeom Jang, Jaesung Jang, *Ulsan National Institute of Science and Technology, Korea*

The coronavirus, with a size range of 60-140 nm, is challenging to collect using inertia-based sampling devices. These viruses can be effectively collected using a water condensation-based sampling device known as a growth tube collector (GTC).

The GTC employs the temperature difference between wetted walls, referred to as the conditioner and the initiator, to grow particles. The air passing through the conditioner is cooled, increasing its humidity. When this cooled air then passes through the initiator, the supersaturated vapor causes water to condense on the surface of the aerosol particles, leading to particle growth. Due to the limited length of the conditioner, if the incoming air is not fully conditioned before entering the initiator, the particles may not grow properly.

Therefore, this study utilized numerical methods to assess the feasibility of using the GTC in various indoor environments by altering the conditions of the incoming air in the growth tube and observing the final size of the grown droplets. When the inlet air temperature is 25 °C and the growth tube operates at 6 LPM, particles with an initial size of 0.05 µm grow to a count median diameter (CMD) of 0.54 µm at an inlet air relative humidity (RH) of 10%. At an RH of 80%, the CMD of the particles increases to 1.44 µm. When the growth tube operates at 1 LPM, the CMD of the particles grows to 5.39 µm and 5.48 µm at RH levels of 10% and 80%, respectively, indicating that the influence of ambient air humidity decreases as the flow velocity through the growth tube decreases. Since the operating flow rate of the sampler is an important factor in determining the sampling time, we identified the need to optimize the operating flow rate based on the sampling air conditions.

2BA.16

WIBS-4+: An Assessment of Its Use a Bioaerosol and Anthropogenic Aerosol Monitor. DAVID O'CONNOR, Jerry Clancy, Emma Markey, Moises Martinez-Bracero, Dominique Baisnee, Roland Sandra-Esteve, *Dublin City University*

This study conducted an intensive real-time monitoring campaign over two months in Saclay, a semi-urban area southwest of Paris, France. The campaign aimed to evaluate the Wideband Integrated Bioaerosol Sensor 4+ (WIBS 4+) device comparing it to the traditional Hirst volumetric sampling method for detecting ambient bioaerosol concentrations, specifically fungal spores and pollen grains. Alongside the WIBS and Hirst devices, meteorological and pollution data were collected from co-located monitoring equipment at the research center, enabling the development of several Multiple Linear Regression (MLR) algorithms.

The results indicated that for Total fungal spores, significant concentration predictors included the A WIBS channel concentrations, southern and southwesterly winds, and NOx emissions. For pollen grains, the additional emission channels in the WIBS 4+ (allowing for D, DE, and E WIBS channel categories) were a strong predictor of concentrations when combined with northerly and easterly winds and atmospheric ammonia levels. Furthermore, the potential for using WIBS 4+ technology to monitor non-biological aerosols was assessed, revealing that black carbon, despite not being of biological origin, strongly correlated with BC WIBS channel particles. It was also influenced by various wind speed and direction parameters. This campaign demonstrates the robust bioaerosol monitoring capabilities of WIBS technology and also its potential use as an air quality monitoring device.

2CE.2

Atmospheric Oxidation of Per- And Polyfluoroalkyl Substances (PFAS) Thermal Decomposition Products and Its Potential for Secondary Organic Aerosol Formation.

LILLIAN TRAN, Linhui Tian, Ying-Hsuan Lin, *University of California, Riverside*

Due to decades of widespread manufacturing and use of per- and polyfluoroalkyl substances (PFAS) to produce water, fire, and oil resistant products, the environment has become contaminated with such substances. During the thermal destruction of PFAS-related substances (e.g., firefighting, thermal treatment, urban fires, etc.), products of incomplete destruction (PIDs) in the form of volatile organofluorines (VOFs) can be emitted into the atmosphere. There is little known about the potential atmospheric transformation of PFAS thermal products. In this research, many unsaturated VOFs were identified from the pyrolysis of PFAS, including those in constrained ring formations. Previous studies have demonstrated the ozonolysis of similar perfluoroalkenes. Hydrogenated VOFs were also identified, which could also be oxidized via OH radicals. We hypothesize that the unsaturated and hydrogenated nature of these compounds creates potential for these VOFs to react with oxidants like ozone and OH to produce more oxygenated organofluorines that can partition in the particle phase and contribute to particle formation. Thermal products of PFAS were generated by pyrolysis of PFOA in its pure chemical form as a model compound to compare to the pyrolysis of PFAS-containing household items. The thermal products were then subject to atmospheric oxidation under a variety of conditions relevant to urban fires. The thermal products and thermal oxidation products were analyzed by a variety of mass spectrometry techniques. This research explores the novel atmospheric implications of PFAS thermal degradation.

2CE.4

Criteria, Greenhouse Gas, and Hazardous Air Pollutant Emissions Factors from Residential Cordwood and Pellet Stoves Using an Integrated Duty Cycle Test Protocol.

NORA TRAVISS, George Allen, Mahdi Ahmadi, *NESCAUM*

Air pollution from residential wood heating (RWH) presents global challenges at the intersection of climate and public health. In the U.S., emissions factors (EFs) are a critical data input into the Environmental Protection Agency's (EPA) National Emissions Inventory (NEI), underpinning air quality research, modeling, planning and decision-making functions at the national, state, local and Tribal levels. However, up-to-date EFs measured from currently available U.S. commercial stoves are an existing data gap. In this study, we used a novel stove testing protocol representing real-world operation called the Integrated Duty Cycle to determine EFs from six U.S. EPA-certified cordwood and pellet stoves, and one popular U.S. uncertified cordwood stove. We measured particulate matter (PM), other criteria pollutants (CO and NOx), nonmethane total hydrocarbons (NMTHCs), greenhouse gases (GHGs), and hazardous air pollutants (HAPs). Compared to the uncertified stove, the catalytic/hybrid cordwood and pellet stove EFs for PM, PAHs, and most HAPs were significantly lower ($p < 0.01$). Noncatalytic and uncertified stove EFs exceeded 2020 NEI EFs for NMTHCs (16.8 and 32.7 g/kg wood burned, dry basis, respectively), and multiple HAPs such as formaldehyde (1.2 and 2.1 g/kg, respectively), benzene (0.4 and 1.5 g/kg, respectively) and many others. The noncatalytic stove PM EF (9.0 g/kg) exceeded the 2020 NEI EF as well. Applying the Pb EF from this study places RWH as the 4th highest source category of Pb in the 2020 NEI. RWH also emits 10 to 30 times more methane (CH_4) compared to oil or natural gas residential heating, raising questions about substitution of wood as a climate neutral heating fuel. In summary, RWH appears to be an underestimated source of PM, methane, NMTHCs, Pb, and multiple HAPs, which has important implications for climate and public health policy in the U.S. and globally.

2CE.5

Characterization of PFAS Using Temperature-Programmed-Desorption Direct Analysis in Real Time Coupled with Mass Spectrometry.

CATALINA BOTERO-CARRIZOSA, Emily Halpern, Alexander Laskin, *Purdue University*

Poly and perfluorinated alkyl substances (PFAS) are considered “forever chemicals” which have drawn attention for their accumulation in water, soil, and organisms, leading to adverse environmental and health impacts. Due to the recent discovery of PFAS found in aerosols released from wildfires, agricultural systems, or oceans spray, PFAS-containing aerosols can travel long distances through the atmosphere. Thus, PFAS species are regarded as contaminants of concern that require identification, quantitation, and evaluation of their gas-particle partitioning in aerosol. In this study, we develop an innovative experimental methodology for the untargeted detection and quantitation of PFAS through temperature-programmed-desorption direct analysis in real time (TPD-DART) coupled with high resolution mass spectrometry (HRMS) for chemical identification and triple quadrupole mass spectrometry (QqQ) for practical applicability and sensitive quantitation. This method requires no sample preparation and yields temperature-resolved measurements particularly important to derive condensed phase-to-gas partitioning parameters, such as apparent enthalpies of evaporation and saturation mass concentration.

2CE.6

Per and Polyfluoroalkyl Substances in Urban Atmospheric Particles in Asian Countries: A Review.

SHAZIA SHIFA, Lovleen Gupta, *Delhi Technological University*

Per- and poly-fluoroalkyl substances (PFAS) are a class of more than 5000–10,000 species of anthropogenic chemicals that are fluorinated aliphatic compounds having strong and stable C-F bonds. These chemicals provide water, stain, and oil-resistant properties and are therefore used in a wide range of daily use and commercial products like paints, adhesives, cosmetics, firefighting foams, cook wares, etc. These are persistent chemicals that are carcinogenic, highly accumulative, and resistant to thermal, chemical, and biological degradation, eventually posing a threat to human health and the environment. Numerous studies have been carried out that focus on the presence of PFAS in soil and water media, however, studies on its presence in the ambient air are limited. This review aims to present the research characterizing PFAS in ambient air in Asian environments, focusing on their identification, extraction procedures, and analytical techniques of determination. The major sets of PFAS and their precursors reported in ambient air include PFOA, PFOS, PFBS, PFBA, PFCA, FTOHs, and diPAPs. The ∑PFAS in the atmospheric environment has been reported in the range 0–1200 pg/m^3. This review also emphasizes the need for policy and regulatory framework for PFAS emissions in ambient air.

2CE.8

Aerosol Emissions from Structural Fires at the Wildland-Urban Interface: From Carpets to Couches and Shingles to Studs. KEVIN RIDGWAY, Anna Helfrich, Jamie Cast, Cristian Medina, Miranda Trujillo, 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 aerosols in WUI regions, with implications for air quality and public health. However, aerosol emissions from structural fires are poorly understood and what we do understand remains fragmented and incomplete. In this work, 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. More than 80 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), electrical sheathing (e.g., polyvinyl chloride), and flooring (e.g., luxury vinyl plank), under pyrolysis and flaming conditions. Aerosol emissions were collected on a combination of Teflon and quartz filters and analyzed offline using a host of analytical techniques. 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 the fuel type, fuel category, 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. Our work contributes to the body of literature focused on understanding the environmental and health impacts from WUI fires.

2CE.9

Chemical Speciation of Biomass Burnings from Shrubland Sagebrush Ecosystem Vegetation. BIANCA MARTINEZ, Chiranjivi Bhattarai, Andrey Khlystov, *Desert Research Institute*

Wild and prescribed fires occur throughout the western and central United States. Over 60% of the landscape in this area is constituted by shrubland and grassland vegetation. The purpose of this study is to determine the emission factors from burning of vegetation of sagebrush ecosystem as few studies have investigated the fire emissions from these landscapes. Four common sagebrush ecosystem shrubland fuels were used: sagebrush (SB), bitterbrush (BB), rabbitbrush (RB), and horsebrush (HB). The experiments were performed in an 8 m3 burning chamber. Samples were collected for analysis of various chemical classes, such as: carbonyls, terpenes, volatile organic compounds (VOCs), and polycyclic aromatic hydrocarbons (PAHs). Carbonaceous aerosols were collected for fresh and aged biomass burning smoke. Collected samples for carbonyls were extracted and analyzed using high performance liquid chromatography coupled with a photodiode array detector (HPLC-PDA); while for the other classes, the collected samples were extracted and analyzed using gas-chromatography coupled with mass spectrometry (GC-MS). Online instruments, such carbon monoxide and carbon dioxide sensors were used to calculate the modified combustion efficiency to obtain the carbon-based emission factors. For carbonyl compounds, HB showed higher formaldehyde (5±3 g/kgC) and acetaldehyde (4±2 g/kgC) emissions, followed by BB, SB, and RB. A similar trend was shown for carbonaceous aerosols. Organic carbon concentrations increased after aging. Among terpenes compounds, highest emissions of alpha-pinene, camphene and eucalyptol were measured for SB; while for RB and HB, beta-myrcene and beta-pinene showed higher emissions. Among PAHs, highest emissions were measured for naphthalene, followed by fluorene and phenanthrene, especially for SB (7E-4±9E-4 g/kgC). Aging reduced PAH concentrations. For example, for SB and RB, naphthalene emissions were reduced by 43% and 21%.

2CE.10

Comparison of the Estimated and the Measured Concentrations of Secondary Organic Aerosol Based on the Measured Concentration of Volatile Organic Compounds (VOC).

JI-WON JEON, Young-Ji Han, Sung-Won Park, Pyung-rae Kim, Hyo-Won Lee, Yun-seo Lee, Soo-Jin Jeong, *Kangwon National University*

Organic compounds, one of the main components of $PM_{2.5}$, are either directly emitted from both natural and anthropogenic sources (primary organic aerosol: POA) or secondarily formed in atmosphere via (secondary organic aerosol: SOA). SOA can be formed through the oxidation of volatile organic compounds (VOCs) primarily by OH, ozone, and NO_3 radicals, generating low volatility products that are subsequently partitioned into the condensed phase. In this study, 52 VOC species were measured using on-line GC (GC 955-611/811, Synspec, NED)in Chuncheon, a medium-sized residential city of South Korea in 2023. $PM_{2.5}$ was also collected and the concentrations of its individual organic matters were measured using GC-MS in order to relate VOC to organic aerosol.

During the measurement period, the average total VOC concentration was 8.7 (± 5.5) ppbv. DHOPA, a tracer of anthropogenic SOAs (ASOAs) and 2-methylthreitol, 2-methylerythritol, 3-hydroglutaric acid, pinic acid, and pinonic acid, the tracers for biogenic SOAs (BSOA) were measured. Average concentrations of DHOPA and total BSOAs, were 3.1 (±2.3) and 23.1 (±18.8) ng/m³, respectively, indicating that BSOAs were actively produced in this city with a forest area of approximately 74%. Notably, the concentration of BSOAs increased to 50.1 ng/m³ in June (summer), and the isoprene concentration during this period was 0.56 (±0.48) ppbv, which was about twice higher than that in the metropolitan (Seoul) and industrial regions (Ulsan). In this study, SOA concentrations were also estimated based on the measurements of VOC and SOA tracers using box model, and the results will be presented at the conference.

2CE.12

Single-Particle Perspective on Aerosol Sources and Aging in New York City and a Downwind Coastal Site during NYC-METS.

KAYLEIGH REILLY, Emily Costa, Yao Xiao, Tiantian Zhu, Xena Mansoura, Zezhen Cheng, Nurun Nahar Lata, Swarup China, Drew Gentner, Rachel O'Brien, Andrew Ault, *University of Michigan*

Understanding the sources and aging of atmospheric aerosols is critical to evaluating their impacts on climate and health. Single-particle analysis can determine the sources of atmospheric aerosols near the point of emission and their evolution through multiphase chemistry (i.e., aging) during transport in the atmosphere. The July-August 2023 New York City metropolitan Measurements of Emissions and TransformationS (NYC-METS) campaign provided a unique opportunity to explore the physicochemical properties of individual particles within a diverse and evolving population at both an urban site and downwind at a coastal Connecticut site. NYC-METS is a part of a larger comprehensive field effort known as AEROMMA, which is an investigation into urban areas to study air quality, atmospheric interactions at the marine-urban interface, and climate change with the ultimate goal of improving our understanding of air pollution. Herein, computer-controlled scanning electron microscopy with energy dispersive x-ray spectroscopy (CC-SEM-EDX) was used to analyze both morphology and elemental compositions of sub- and super-micron aerosol particles at both sites. Additionally, transmission electron microscopy (TEM) was used to gain further insight into morphology of sub-micron aerosol particles. Using these techniques we observe an increased number of sea spray aerosols (SSA) at the coastal site compared to NYC, with a significant fraction showing chloride depletion due to aging. There is also clear evidence of atmospheric processing between the two sites based on the morphology and composition of soot particles. These observations between combustion and marine aerosols provided important contexts to the sources and aging occurring during this campaign. This comparison between the urban and downwind coastal sites is helping to shed light on air pollution sources and evolution, along with its effect on air quality in a highly populated region.

2CT.1

Initial Measurements and Findings from the Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT) Houston-Liberty site. SUBIN YOON, Fangzhou Guo, Shan Zhou, Robert Griffin, Roya Bahreini, Ann M. Dillner, Armistead G. Russell, Nga Lee Ng, James Flynn, *University of Houston*

The Houston-Liberty site, situated approximately 70 km northeast of the Houston urban core, serves as one of twelve Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT) U.S. measurement sites for characterizing aerosol chemical composition and physical properties. This semi-rural site measures background and/or downwind aerosol from the Houston metropolitan area depending on wind direction. The air quality in the region is characterized by a myriad of urban, industrial, and biogenic emission sources in a relatively highly oxidizing summer atmosphere.

The deployed ASCENT instruments include the Aerosol Chemical Speciation Monitor (ACSM) for non-refractory aerosol composition and mass concentration, a Scanning Mobility Particle Sizer (SMPS) for aerosol number size distribution and concentration, an Xact for trace metals, and an Aethalometer for black and brown carbon measurements. All four instruments were operational by early spring of 2024. This presentation will provide the initial findings of the spring and summer 2024 aerosol measurements coupled with meteorological parameters to better identify and understand potential sources, dynamics, and trends that are driving particle pollution in this region.

2CT.2

Source Apportionment of Aerosols at ASCENT Network Site Cheeka Peak Observatory. OLIVIA HAKAN, Odelle Hadley, Philip Rund, Courtney Winck, Roya Bahreini, Ann M. Dillner, Armistead G. Russell, Nga Lee Ng, Joel A. Thornton, *University of Washington*

The Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT) is a recently developed network with 12 measurement locations across the US. Each site has been equipped with an aerosol chemical speciation monitor (ACSM), an aethalometer (AE33), an Xact multi-metals monitor (Xact625i), and a scanning mobility particle sizer (SMPS) to measure aerosol concentration and composition in near-real time. These instruments measure non-refractive mass loading and composition, light-absorbing particle concentration, metal and element concentrations of 46 different species, and the total particle concentration and size distribution, respectively. Cheeka Peak Observatory is located on the Olympic Peninsula, roughly 75 miles from the nearest city, Port Angeles, and less than 5 miles from the Pacific Ocean. We analyze results from the first year of all four instruments sampling, including source apportionment from the Xact and ACSM using Non-Negative Matrix Factorization (NNMF) and comparison to data from the co-located IMPROVE and NCore networks. Based on measurements from the Xact, the metals and elements at CPO are dominated by terrestrial and marine sources: chlorine (98.2 ng/m3), aluminum (83.7 ng/m3), sulfur (56.3 ng/m3), potassium (8.3 ng/m3), and silicon (6.4 ng/m3), are, on average the most abundant species measured at the site. The ACSM reports speciated non-refractory PM2.5 mass to be mostly organic aerosol with an average of 1.21 µg/m3, followed by sulfate 0.38 µg/m3, nitrate 0.076 µg/m3, ammonium 0.073 µg/m3, and then chloride 0.025 µg/m3. In this data set, we have observed episodic organic aerosol from wildfire smoke and forestry-related practices, particle growth events, and evidence of rare heavy metals from maritime vessel traffic.

2CT.3

Aerosol Chemical Composition and Cloud Interactions: Findings from the SCILLA Campaign. BRADLEY RIES, Alexander B. MacDonald, Dongli Wang, Minghao Han, Sierra Bollinger, Mason Leandro, Lisa Welp-Smith, Patrick Chuang, Mikael Witte, Andrew Metcalf, Don Collins, Roya Bahreini, *University of California, Riverside*

The SCILLA (Southern California Interactions of Low cloud and Land Aerosol) campaign was a comprehensive airborne research project aimed at investigating aerosol-cloud interactions and their impact on regional climate and air quality. In June 2023, we conducted 21 research flights onboard a Navy Twin Otter aircraft, equipped with a suite of instruments including a mini Aerosol Mass Spectrometer (mAMS), a Single Particle Soot Photometer (SP2), a scanning Electrical Mobility Spectrometer (SEMS), and cloud droplet counters, among others. Our flights sampled diverse air masses in locations near the coastal pollution sources of Los Angeles Basin (which often are transported out over the water) and off of the coast of San Diego, including nearshore and offshore areas, San Clemente Island, and various cloud regimes (in-cloud, below-cloud, above-cloud and in the cloud wake of the island).

The mAMS alternated sampling through an isokinetic inlet in cloud-free air, a Counter-flow Virtual Impactor (CVI) in clouds, and an oxidation flow reactor. This investigation focuses on a subset of flights to investigate how atmospheric aging and cloud interactions in the marine environment affect aerosol composition. For this, we analyzed compositional data collected from the "missed-approach" flight patterns at Santa Monica, Long Beach and Torrance Airports and contrasted them with our observations of cloud residuals and aerosols in cloud-free air masses off of the coast of San Diego. Our results and their significance in understanding pollution-cloud interactions will be discussed.

2CT.5

Aerosol Formation from Oil and Gas Development in the Eagle Ford Shale. LEA EL KHOURY, Katarina Konon, Austin Turner, Evelyn Deveraux, Chou-Hsien Lin, Pearl Abue, Shihao Zhai, Albert Kyi, Mrinali Modi, Leif Jahn, Daniel C. Blomdahl, Pawel K. Misztal, Lea Hildebrandt Ruiz, *University of Texas at Austin*

Oil and gas development (OGD) has grown substantially in the United States; yet, associated airborne emissions and air quality impacts are poorly characterized. Here we combine insights from three ambient measurement campaigns conducted in spring 2021 and spring and fall 2023 in Karnes City, Texas, located in the middle of the Eagle Ford Shale (EFS). We observed episodic high aerosol concentrations in all campaigns, with maximum hourly averaged PM_1 (particulate matter with a diameter ≤1 µm) concentrations of 27 µg m^{-3} in spring 2021, 39 µg m^{-3} in spring 2023, and 12 µg m^{-3} in fall 2023. In fall 2023, organic aerosol dominated non-refractory PM_1 (60% of the mass on average) while in spring 2021 sulfate and organics were present at similar levels. One of the sulfate sources in the spring was the shipping activity in the Gulf of Mexico southeast of the site. During plume periods in the fall, the organic aerosol formed up to 75% of PM_1 and the wind direction was generally from the northeast, where oil and gas well density is higher. Positive matrix factorization analysis showed that the organic aerosol (OA) was primarily oxidized OA (OOA), consistent with the OA being primarily secondary organic aerosol (SOA) formed from volatile organic compound (VOC) oxidation. VOC plumes were followed by OA plumes and gas-phase measurements revealed elevated concentrations of these VOCs including large alkanes and BTEX (benzene, toluene, ethylbenzene, xylenes), which can result in the formation of SOA.

Thus, our measurements suggest that VOCs emitted from OGD result in substantial formation of organic aerosol. This is relevant to air quality within the EFS and other OGD regions, as well as downwind regions such as San Antonio, Texas, which will struggle to meet the new EPA standard for fine particulate matter.

2CT.6

Volatile Organic Compound Emissions from Oil and Gas Development and Impacts on Aerosol Formation. KATARINA KONON, Pearl Abue, Leif Jahn, Lea El Khoury, Austin Turner, Daniel C. Blomdahl, Evelyn Deveraux, Chou-Hsien Lin, Mrinali Modi, Kristi McPherson, David T. Allen, Pawel K. Misztal, Lea Hildebrandt Ruiz, *University of Texas at Austin*

Oil and gas development (OGD) in the United States continues to grow thanks to technologies such as hydraulic fracturing and horizontal drilling. However, the effects of OGD on air quality, climate, and human health are poorly characterized. We took gas-phase and particle-phase measurements in the spring and fall of 2023 in Karnes City, a rural town located within a large oil and gas production region in south-central Texas called the Eagle Ford Shale. This work focuses on gas-phase volatile organic compound (VOC) emissions measured using a Vocus high resolution proton transfer reaction time-of-flight mass spectrometer (Vocus), iodide high resolution time-of-flight chemical ionization mass spectrometer (CIMS), and automated gas chromatograph (GC). Overall, we find that OGD emits VOCs with high potential to form secondary pollutants such as organic aerosol.

Throughout both campaigns, we observed intermittent plumes of alkanes and aromatic hydrocarbons. These plumes vary in duration from a few minutes to a few hours and their intermittent behavior cannot be fully explained by meteorology, suggesting that the plumes are due to OGD emissions. We observed a maximum concentration of 5.4 parts per million (ppm) methane, which is over two times background levels (~2 ppm). The average ratio of ethane to methane in plumes was 0.18, which is consistent with previously reported shale gas characteristics in the Eagle Ford Shale. In the Vocus data, we see some larger molecules (>C10) that are often not detected by traditional GC analysis and can contribute substantially to secondary organic aerosol formation. In the CIMS data, we see chlorine which is a highly reactive oxidant. Chlorine and other oxidants react with VOCs to form secondary pollutants including ozone and secondary organic aerosol, which is a problem for human health and compliance with federal air quality standards in downwind regions such as San Antonio.

2CT.7

Dark Brown Carbon Dominates Aerosol Light Absorption in Urban Anthropogenic Emissions. YUEZHI (AUGUST) LI, Taveen Kapoor, Joseph V. Puthussery, Gregory W. Vandergrift, Zezhen Cheng, Guodong Ren, Joshin Kumar, Nurun Nahar Lata, Benjamin Sumlin, Felipe Rivera-Adorno, Alexander Laskin, Rohan Mishra, Swarup China, Rajan K. Chakrabarty, *Washington University in St. Louis*

Brown carbon aerosols are important climate forcers that alter the Earth's radiative budget by absorbing and scattering incident solar radiation. However, brown carbon's highly variable physicochemical and optical properties render large uncertainties in measuring and modeling its climatic impacts. The growing anthropogenic sources due to global urbanization are potential emitters of brown carbon particles, highlighting the urgency to understand their properties more thoroughly.

In this study, we present the bulk and particle-scale absorption, morphology, volatility, and chemical composition of ambient aerosols in La Porte, Texas, an urban coastal city influenced by mixed anthropogenic emission sources such as traffic and petrochemical industries. Our measurements show significant brown carbon absorption at near-infrared wavelengths, accounting for 53.6 ± 16.6% (0.97 ± 0.55 Mm^{-1}) at 721 nm and 37.8 ± 18.8% (0.34 ± 0.31 Mm^{-1}) at 1047 nm. This is attributed to the dominance of strongly absorbing dark brown carbon comprised of extremely low volatility organic compounds, contributing to 20.1 ± 9.5% (0.28 ± 0.06 $\mu g/m^3$) of the total carbonaceous aerosol mass. Particle-scale measurements on sampled dark brown carbon particles also show strong absorption across the ultraviolet-visible-infrared spectrum, with mean imaginary refractive indices of 0.106 at 550 nm and 0.055 at 1047 nm. These particles, unlike tar balls, exhibit non-spherical morphology, but their water insolubility, low volatility, and thermal stability are consistent with reported dark brown carbon properties. The observed dark brown carbon particles are only partially soluble in common organic solvents, with the soluble fraction predominantly comprised of aged (O/C > 0.5) organosulfates. Our findings reveal possible underestimation on brown carbon absorption in urban environments in past studies assuming negligible near-infrared brown carbon absorption. Given the sheer number of cities like La Porte globally, a robust parameterization of anthropogenic dark brown carbon can significantly improve climate models' estimation on aerosol radiative forcing and associated warming effects.

2CT.8

Investigating the Complex Interactions between Aerosols and Meteorology and Their Impacts on the Aerosol Direct Radiative Forcing in Coastal Texas. TAMANNA SUBBA, Michael Jensen, Ashish Singh, Rebecca Trojanowski, Dié Wang, Maria Zawadowicz, Chongai Kuang, *Brookhaven National Laboratory*

Recent changes in the global aerosol burden have significantly altered aerosol direct radiative forcing (DRF) which indicates aerosol influence on climate via perturbation of the radiation budget. The DRFs estimated using the Clouds and the Earth's Radiant Energy System (CERES) data indicate notable spatial and temporal variations of DRF across the South and Southeast United States over recent decades. The TRacking Aerosol Convection Interactions Experiment (TRACER) provides a unique opportunity to study aerosol processes that affect climate in the coastal environment of the Southern Texas region. During summertime, this region experiences interactions of mesoscale meteorological and aerosol microphysical phenomena. For example, inland-penetrating sea breeze fronts modify atmospheric conditions and aerosol properties, potentially affecting their spatiotemporal distribution and radiative impact. The changes in DRF are considered to be primarily driven by changes in anthropogenic activities associated with population growth and urbanization. However, the effect of interactions between the aerosol environment and the mesoscale meteorological phenomena on DRF is less studied. A comprehensive suite of measurement data is used to understand these processes, including aerosol size distribution, chemical composition, aerosol optical depth, asymmetry parameters, and single scattering albedo, complemented by detailed meteorological observations during the summer over the TRACER environment. DRF is estimated using the measurement-informed Optical Properties of Aerosols and Clouds (OPAC) software package and the Santa Barbara DISORT Atmospheric Radiative Transfer (SBDART) radiative transfer model. The WRF-Chem model simulations further elucidate the impact of meteorological phenomena and aerosol environment on the DRF from local to regional scales.

2CT.9

Demonstration of Sensitivity of Backscattering to Spherical Particle Physical Properties: Size, Refractive Index, and Shape Deviations. PRAKASH GAUTAM, Hans Moosmüller, Christopher M. Sorensen, Justin Maughan, *Desert Research Institute*

Backscattering of light by spherical particles is greatly affected by the small change in particle physical properties: size, refractive index, and shape deviations. We present how the non-descriptive backscattering pattern evolves compared to the comprehensible forward scattering, depending on the particle's physical properties. The demonstration is carried out by changing the physical properties of spherical particles by ± 2.5% and analyzing the same data using two analysis methods: vs. the linear scattering angle, θ–space and logarithmically when plotting them vs. the magnitude of the scattering wave vector q, called Q–space analysis. The results showed systematic, descriptive evolution of the forward scattering pattern, which is clearly shown in logarithmic Q–space, whereas non-descriptive, seemingly chaotic evolution within the backscattering regime, as displayed in linear θ–space. This study emphasizes that while Mie's theory provides accurate light scattering results for spherical particles, interpretation of measured backscattering data requires accurate characterization of particle physical properties. Overall, the results offer practical value to those engaged in particle scattering and to professionals within the lidar and remote sensing communities.

2CT.10

Characterization of Submicron Aerosols at the ASCENT Site in the Pristine North American Boreal Forest. JAMES CAMPBELL, Roya Bahreini, Ann M. Dillner, Armistead G. Russell, Nga Lee Ng, Jingqiu Mao, *University of Alaska Fairbanks*

The boreal forests of the northern hemisphere represent the largest land biome on Earth, and their interactions with the atmosphere are essential to understanding future climate. Extensive work has been done in the European boreal forest to study forest-climate interactions, biogenic emissions, and aerosol chemistry. However, little work has been done in the North American boreal forest, despite differences in tree composition and VOC emissions. Since the summer of 2023, we deployed four instruments (ACSM, SMPS, Xact, AE33) at a remote site about 20 km south of Delta Junction, Alaska as part of the Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT). This site is co-located with both NEON and AERONET networks. The ACSM shows that fine particle mass composition is dominated by organics, while the total mass is low year round except during wildfire periods. Extremely low concentrations of sulfate, nitrate, ammonium, and black carbon (all averaging less than 0.05 $\mu g/m^3$) during non-wildfire periods suggest very little anthropogenic or biomass burning influence at the site. We further compare the ACSM measurements between our site and the Hyytiälä boreal forest site in central Finland, and show a weaker temperature dependence of organic aerosols at our site. Further investigation is underway to understand the differences and similarities on biogenic secondary organic aerosol formation between North American and European boreal forests.

2CT.11

Aerosol-Correlated Activation and Supersaturation Variability in Coastal Marine Stratocumulus during EPCAPE. JERAMY DEDRICK, Atsushi Osawa, Lynn M. Russell, *Scripps Institution of Oceanography*

The complex mixture of highly polluted and nearly pristine air that influences cloud condensation nuclei (CCN) in coastal regions serves as a unique experiment to explore process-specific constraints on highly uncertain aerosol-cloud interactions in global climate models. Measurements at Scripps Pier and Mt. Soledad during the DOE ARM Eastern Pacific Cloud Aerosol Precipitation Experiment (EPCAPE) in La Jolla, California were used to characterize the in- and sub-cloud size distribution of aerosol and cloud droplets during low-cloud events, signatures of processing following these events, and the aerosol conditions preceding them. Three lognormal modes were superimposed onto the measured size distributions (10 nm-10 µm) representing Aitken, accumulation, and sea spray modes using an automated fitting procedure. Typical pre-cloud aerosol size distributions were characterized by a single, broad accumulation mode that developed into a bimodal submicron distribution proceeding cloud development and dissipation. The bimodality, represented by a signature of the in-cloud critical activation diameter, known as the “Hoppel Minimum”, correlated (r=0.4) with the total aerosol concentration for low aerosol conditions (<400 cm-3) and were associated with small activation diameters (<75 nm). Based on in-cloud hygroscopicity determined from submicron composition and cloud condensation nuclei measurements, higher effective cloud supersaturations were inferred for low aerosol conditions than more polluted conditions (>400 cm-3). The relationship of the number of particles acting as CCN (indicated by the accumulation mode number) with the Hoppel Minimum diameter shows evidence of aerosol-correlated feedback on supersaturation and cloud drop activation that was varied with the aerosol conditions. These results provide activation characterization that connects aerosol sources and cloud properties in this complex coastal environment.

2HR.1

Exposure to Aged Vaping Emissions at an Air-Liquid Interface: Potential for Disruption of the Respiratory Epithelial Barrier.

WONSIK WOO, Linhui Tian, Ying-Hsuan Lin, *University of California, Riverside*

Vaping indoors has brought up concerns regarding its effects on indoor air quality due to the release of massive amounts of aerosol during a typical session. Once in the air, these vaping emissions are subjected to aging processes that are governed by ambient oxidants and gas-particle partitioning processes. Recent work has shown that e-cigarette aerosols can be effectively aged by ambient levels of ozone (O3), forming reactive oxygen species (ROS) and carbonyls that are enriched within the aged aerosols. The toxicity associated with second-hand exposure to these aged aerosols has not been fully explored, but there is an expectation that these aged emissions pose a greater risk to pulmonary health compared to their fresh counterparts. In this study, our goal is to model this process of second-hand exposure by utilizing human bronchial epithelial cells that are grown at an air-liquid interface (ALI) and undergo exposures with an in vitro aerosol exposure system (VITROCELL® 6/4 CF). E-cigarette aerosols will undergo aging in a 0.5 m3 FEP chamber by reactions with O3. The chamber will be connected to the exposure system, where NHBE cells will be exposed to both fresh and aged vaping emissions. Differential effects that influence the integrity of the respiratory epithelium from fresh and aged exposures will be determined by measuring differences in transepithelial electrical resistance (TEER) as well as lactate dehydrogenase (LDH) release. Furthermore, gene expression analysis with RNA-Seq and changes in cellular lipid profiles with LC-MS/MS will provide insight about the cellular mechanisms that mediate the toxicity of our aged e-cigarette aerosols. Since the aging process of e-cigarette aerosols will induce the formation of potentially toxic compounds, we expect to see significant differences in the toxicological endpoints and biomarkers that indicate the ability of aged e-cigarette aerosols to reduce the integrity of the respiratory epithelium.

2HR.2

Increases in College Use of Vaping and Chemical Exposure.

HUNTER WELCH, Whitney Spaeth, Genny Carrillo, Maria King, *Texas A&M University*

In February 2020, the Centers for Disease Control and Prevention (CDC) confirmed 2,807 e-cigarettes or vaping use-associated lung injury cases and 68 deaths attributed to that condition. There are thousands of chemical ingredients in vape products, most of which are yet to be identified. Vaping is associated with chronic lung disease, asthma, and cardiovascular disease. This study investigates potential deleterious alterations in ambient air quality and selected aspects of the health of college students where e-cigarettes are smoked and compare results to the air quality and its health effects on college students living in dorms/apartments without e-cigarette smoking. Using a model hospital chamber equipped with ventilation the wetted wall cyclone nanoaerosol collector developed in the team's laboratory was used with Inductively Coupled Plasma Mass Spectrometry (ICP-MS) for the spatial-temporal collection, detection, and quantitation of vape components collected in the exhaled breath of vaping volunteers and in the residual products left after the vape. The composition of the lung microbiome in the collected samples was delineated by Illumina sequencing. In addition, FENO by NIOX was used to measure airway inflammation and changes in biomarkers in response to the chemical aerosols. Identification of the residual products and exposure to them for vaping and non-vaping persons will help understand the health effects of the e-cigarettes. Findings from this study will have significant research, clinical, and policy implications by enhancing understanding of this profoundly important and currently understudied area concerning the most widely adopted and fastest growing alternative nicotine delivery products in the U.S.

2HR.3

Evaluating Inflammatory Responses in in vitro Submerged Exposure to Aerosols. SEONGBIN JO, Liang-Hsin Chen, Shuichi Takayama, Nga Lee Ng, *Georgia Institute of Technology*

In vitro studies using human lung cells or pneumocytes have been frequently used in studying human health effects. These studies' high-throughput and pollutant-specific capabilities allow for screening of potential pulmonary toxic aerosols and determining biological mechanisms with small quantities of aerosols compared to in vivo tests. However, in vitro aerosol studies have challenges with respect to the use of more physiologically relevant cell culture and exposure methods. Typical methods of in vitro aerosol exposure include utilizing submerged exposure to the mono-cultured cells for toxicity studies. Typical submerged cells involve dissolving a portion of particulate constituents from filter samples in the media. On the other hand, cells cultured and exposed in air-liquid interface (ALI) ensures more physiologically relevant cell model though multiple challenges in aerosol distribution and deposition efficiency remain. Here, we demonstrated the inflammatory effects of submersion with different duration with our air-blood barrier array (ABBA) cell model. The ABBA cell model consists of endothelial and epithelial cells while epithelial cells are cultured in ALI. Our previous studies showed that inflammatory responses from submersion hinder investigating in vitro aerosol toxicity. Our results aim to improve the submerged cell exposure conditions to minimize background effects from inflammatory responses from submersion. Interleukin-8 (IL-8) and transepithelial electric resistance (TEER) will be measured with different conditions of submersion to evaluate the inflammatory response and barrier functions of the cells. The measured inflammatory responses are used to assess the submersion effects and determine more physiologically relevant exposure conditions.

2HR.4

Particulate Matter Exposure and Alzheimer's Disease: In Vivo Insights into Neurotoxic Mechanisms. JOSEPH V. PUTHUSSERY, Yuezhi (August) Li, Shu-Wen You, Clare Wallace, Jessica Restivo, Carla M. Yuede, Rajan K. Chakrabarty, John Cirrito, *Washington University in St. Louis*

A growing body of epidemiological research identifies ambient particulate matter (PM) as a potential neurotoxin 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. Previous studies in AD mouse models have focused on the effects of long-term exposure to air pollution, but the immediate changes in brain activity during acute PM exposure have been technologically challenging to monitor.

In response, we have developed a whole-body mouse exposure chamber integrated with an in vivo microdialysis (MD)-based system for real-time measurement of brain interstitial fluid (ISF) Aβ peptide levels. This setup comprises a state-of-the-art in situ measurement technique and houses two mice in individual RaTurn cages designed for movement and ad-lib access to food and water. Microdialysis probes, implanted in the mice's hippocampus, allow for continuous ISF sampling in awake, freely moving mice at 60-minute intervals over three days. Our findings show that Aβ levels vary significantly with the type of pollutant; low volatility organic aerosols (LVOA) induce a sharp increase in Aβ peptides (~100%) shortly after two-hour exposure. Ongoing experiments aim to dissect the mechanisms behind these changes by investigating oxidative stress markers and reactive oxygen species generation in response to various pollutants through a combination of in vivo and in vitro studies.

2HR.5

High-resolution and High-throughput Toxicity Assessment of Ambient PM2.5 with a Microfluidic Cell Assay. ANNA KAEHR, Guillaume Aubry, Fobang Liu, Seongbin Jo, Hang Lu, Nga Lee Ng, *Georgia Institute of Technology*

PM2.5 exposure is associated with both acute respiratory effects in the short term and chronic lung disease in the long term. Due to the chemical complexity and diversity of ambient aerosols, there is a need to screen a wide range of aerosol compounds for their toxicity to develop predictions on human health. As the mechanisms of aerosol damage likely depend on the aerosol properties and chemical composition, it is also useful to monitor multiple biological phenotypes to draw a more holistic understanding of lung injury. Here, we employ a microfluidic platform to assess the impact of aerosols on murine alveolar macrophages. With automatic dilution of extracted SOA, we can continuously deliver a range of doses to the macrophages which are compartmentalized for ease of single-cell analysis. We can simultaneously measure multiple biomarkers over time, including intracellular reactive oxygen species (ROS), programmed cell death activity, and mitochondrial membrane potential (MMP). With this platform, we investigate the toxicity of PM2.5 in the Atlanta metropolitan area, a location known to have influences from both biogenic and anthropogenic sources. Our preliminary results are for the winter season, a time of year that has strong influences from prescribed burns in the southeastern United States and has elevated concentrations of biomass burning organic aerosols (BBOA) compared to biogenic aerosols. This microfluidic platform can identify cell-level responses (high-resolution) while also being a more rapid and cost-effective (high-throughput) alternative to traditional well plate cell assays, improving the ability to screen a broader set of aerosols and assess their implications on human health.

2HR.6

Pyrazines in Waterpipe Tobacco Smoke. Austin Pronk, CINDY HAUSER, *Davidson College*

Waterpipe tobacco, also known as shisha, is becoming an increasingly popular method of consuming tobacco due to additives that make the smoking process more enjoyable for the user. Pyrazines are a family of semi-volatile nitrogen containing heterocyclic compounds that are used to create a nutty flavor in the syrup of shisha. Pyrazines have been shown to enhance the addictiveness of tobacco smoking. Previous studies in our lab show that Trifecta TKO has 3323 µg pyrazines in 10 g of the unsmoked shisha, with only 884 µg present in the shisha post-session and 197.2 ug in the bowl water. In this study, we report on the pyrazine composition in waterpipe tobacco smoke for Trifecta TKO. An electronic smoking apparatus collected particulate matter on quartz fiber filters and gas phase compounds on Empore SDB-XC disks using a modified Beirut method of 3 second puff length, 17 second interpuff interval and12.3 Lpm inhalation rate. Particulate matter was extracted with water, concentrated using C18 SPE cartridges and quantified using standard addition and analysis via gas chromatography-mass spectrometry in selective ion mode. The SPE disks were extracted with an elution of 9:1 hexanes:ethyl acetate and quantified using external standards. It was found that TKO contained a total of 270 µg of pyrazine per smoking session between the quartz filters and the SPE disk.

2HR.7

Formation of Free Radical Oxidants in the Aerosols Produced from Vaping Different Nicotine Salts in Electronic (e-) Cigarettes.

NICHOLAS ROBERTSON, Lillian Tran, Guodong Rao, Haylee Hunsaker, Elizabeth Chiu, Brett Poulin, Amy Madl, Kent Pinkerton, R. David Britt, Tran Nguyen, *University of California, Davis*

Recently, high concentrations of organic acids have been added to the nicotine in electronic (e-) cigarettes to produce nicotine salts, which reduces the bitter and harsh sensation of vaping freebase nicotine. We investigated whether organic acids in nicotine salt e-liquids may alter the redox environment within the e-cigarette by interacting with trace metals in the e-liquid, which may impact free radical formation within the aerosol. Aerosol formation and production of free radicals from a fourth-generation e-cigarette device were investigated with 2 wt.% nicotine salt solutions composed of eight organic acids used in commercially available e-liquids: benzoic acid, salicylic acid, lactic acid, levulinic acid, succinic acid, malic acid, tartaric acid, and citric acid. Additionally, results from benzoate nicotine salt e-liquids with nicotine to benzoic acid ratios of 1:2 (pH 4), 1:1 (pH 7), and 2:1 (pH 8) were compared to those from freebase nicotine e-liquid. The radical yields of each aerosolized e-liquid were quantified by spin-trapping and electron paramagnetic resonance (EPR) spectroscopy. The EPR spectra of free radicals in the various nicotine salt aerosols mirrored those of reactive oxygen species (ROS) generated by the Fenton reaction. Benzoic acid, citric acid, and tartaric acid were the only nicotine salts examined that produced a notable ROS yield. E-liquids containing salicylic acid, lactic acid, levulinic acid, succinic acid, and malic acid produced less ROS than the 2 wt.% freebase nicotine e-liquid, suggesting organic acids may both facilitate and hinder the production of ROS. Results from this study have important implications for ROS-mediated health outcomes that may be of interest to vaping consumers, manufacturers, and regulatory agencies.

2HR.8

Characterization of the Aerosol Yield and Toxic Emissions Profile from the Addition of Terpene Flavorants when Vaping Delta-8 and Delta-10 Tetrahydrocannabinol (THC) Distillate on a Cannabis Vaping Device.

HAYLEE HUNSAKER, Elizabeth Chiu, Nicholas Robertson, Tran Nguyen, *University of California, Davis*

The 2018 Farm Bill that legalized industrial hemp has contributed to the wide commercial availability of hemp-derived tetrahydrocannabinol (THC) isomers: delta-8 and delta-10 THC. Vaping the neat distillate of these THC isomers in an electronic (e-) cigarette device is becoming popular among youth. The distillate is either vaped by itself or with the addition of terpenes flavorants. This study investigates the aerosol formation and production of harmful and potentially harmful carbonyls in the aerosols produced from vaping delta-8 distillate, delta-10 distillate, and distillate mixed with a commercial terpenes mixture at varying mass concentrations on a cannabis vaping device equipped with a ceramic coil. We quantified the emission yields of 20 carbonyls and organic acids using high performance liquid chromatography (HPLC) coupled to high resolution mass spectrometry for exact mass determinations. Our results suggest that carbonyl emission profile is highly influenced by the terpene mix concentrations, with the exception of propionaldehyde and glyceraldehyde; however, the aerosol concentration yields from vaping did not significantly change upon addition of terpenes to the THC distillates. Little to no differences in carbonyl formation and aerosol yield were observed between the two THC isomers. This work suggests that the addition of terpenes to THC distillate generally increases the production of carbonyl toxicants within the vaping device, as the terpene additives are likely the most easily degraded component of the vape liquid solution.

2HR.9

RH-dependent Phase Transitions and Other Physicochemical Properties of Respiratory Aerosols via Fluorescence Probe Spectroscopy. ANGEL GIBBONS, Paul Ohno, *Auburn University*

Understanding the viability of viruses contained in respiratory particles and the connections between this viability and the relative humidity (RH)- and temperature-mediated physicochemical properties of the particles themselves is critical to mitigate respiratory disease transmission. Here we present the use of fluorescence probe spectroscopy to investigate the phase state of model respiratory particles. In this technique, fluorescent molecules are incorporated into the particles of interest and their polarity-dependent emission properties are used to deduce particle phase state. Particles consisting of mucin/salt mixtures, a growth medium, and simulated lung fluid were studied across an RH range of 30-80%. Phase separation between the organic and inorganic constituents was observed at an RH that was dependent on the chemical composition of the particles. Furthermore, we demonstrate that volatilization of probe molecules and subsequent condensation can be used to incorporate the molecules into preexisting particles. This technique enables the study of real exhaled respiratory particles using fluorescence probe spectroscopy. Finally, we discuss the outlook for fluorescence probe spectroscopy in the field, including its use to investigate other physicochemical properties such as pH and viscosity as well as its application more chemically-complex systems such as real respiratory and environmental aerosols.

2HR.10

Optical-based Measurement of Protection Factors for Powered Air-Purifying Respirators. XINYI NIU, Chandrashekhar Choudhary, Michael Yermakov, Tao Li, Sergey A. Grinshpun, Jun Wang, *University of Cincinnati*

Powered air-purifying respirators (PAPRs) are widely used by healthcare workers to protect against inhalation hazards. However, their efficacy can be compromised by a poor initial fit which may progressively deteriorate during work. The traditional respirator fit testing relies on specialized equipment such as TSI PortaCount® that is not designed for a real-time performance monitoring while the wearer is working. Developing a field portable device to conduct real-time performance monitoring of PAPRs is critical since the respirator fit can substantially change during use. A novel device named Exposure Protection Integrated Communicator (EPIC) was prototyped for direct-reading and real-time monitoring of respirators. EPIC employed a pair of optical-based sensors to monitor concentrations inside and outside of a respirator, quantitatively evaluate the protection factor, correct readings with algorithms, and alert wearers if protection is compromised.

The prototype EPIC was evaluated utilizing a manikin headform connected to a breathing simulation system to simulate a sinusoidal breathing pattern of human. The PortaCount® served as the reference measurement device. The outcome was expressed as a protection factor (PF), a ratio of the particle concentrations outside versus inside of the respirator. Flow rates of the tested PAPR were adjusted to achieve PF values of 10, 50, and 100 as reference points. The correlation coefficients (CC) between PF_{EPIC} and $PF_{PortaCount}$ at different ambient concentrations were calculated. A high CC of 0.99 was achieved at the ambient concentration of 50,000 ~ 60,000 particles/L. The high correlation is appealing since EPIC and PortaCount® were based on different measuring principles and particle size ranges. EPIC did have a relatively low CC in extreme situations, and a supervised machine-learning approach will be used to enhance its performance. The results demonstrate the EPIC's ability to quantitatively monitor the respirator faceseal leakage; it is wearable and does not interfere with job functions.

2HR.11

Dust Under the Radar: Rethinking How to Evaluate the Impact of Dust Events on Air Quality in the United States. KARIN ARDON-DRYER, Jenny Hand, Katherine Clifford, *Department of Geosciences, Texas Tech University*

Dust is an important and complex constituent of the atmospheric system, having significant impacts on the environment, climate, air quality, and human health. Although dust events are common across many regions of the U.S., their impacts are not often prioritized in air quality mitigation strategies. We argue that there are at least three factors that result in dust receiving less attention, and these factors limit our understanding of the impacts of dust events on its many social and environmental impacts, including its impact on air quality and human health. These factors include (1) sparse monitoring stations with irregular spatial distribution in dust-influenced regions, (2) inconsistency with dust definitions and sampling methods, and (3) sampling frequency and schedules, which can lead to missed dust events or underestimation of dust particle concentrations. Without addressing these three factors, it is challenging to characterize the full impacts of dust events on air quality in the U.S.

2HR.12

Characterization of Sources and Sinks of the Oxidative Potential of Particulate Matter Emitted from Household Sources. P. S. GANESH SUBRAMANIAN, Brent Stephens, Mohammad Heidarinejad, 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 is used as a surrogate metric to estimate PM toxicity. Although people spend over 80% of their time indoors, literature on OP of PM emitted from indoor sources is limited. In this study, we plan to collect PM emitted from common household sources (unscented-candles, incenses, cigarettes, ultrasonic humidifiers, essential oil diffusers, toasters, and air fryers) using a clean-controlled-environmental-chamber and develop an OP emission inventory from these sources to characterize the sources and sinks of OP of indoor PM in typical US homes. We will collect time-resolved PM samples (i.e., 10-12 samples/source during each emission experiment) either using a manifold filter holder configuration or using a mist chamber (MC) to directly collect PM in liquid (water-suspension). The MC will be connected to a programmable syringe pump and multi-position valve to enable semi-automated multi-sample collection. The particle number concentrations (PNC) in the chamber will also be quantified at 2-min time-intervals using a combination of scanning mobility particle sizer (SMPS) and optical particle sizer (OPS) in tandem. The OP of PM collected on the filters/water-suspension will be analyzed using three widely used acellular OP assays; dithiothreitol depletion (OP_{DTT}), glutathione depletion (OP_{GSH}), and hydroxyl radical generation (OP_{OH}). The time-resolved OP and PNC data would be analyzed using a well-mixed mass balance model approach to estimate the individual mechanistic source and sink parameters that govern the physicochemical processes of indoor OP and PM. We anticipate the outcome of this approach to provide us the emission rates (E_{OP} and E_{PNC}) and first-order loss rates (k_{OP} and k_{PNC}) of OP and PNC, which would assist in further our understanding on the evolution and dynamics of indoor generated PM and its health effects.

2HR.13

Exposure to Black Carbon (BC) and Secondary Aerosol (p-SO42- and p-NO3-) Components of PM2.5, and Cardiopulmonary Morbidity in Jeddah, Saudi Arabia. HAIDER KHWAJA, Shedrack Nayebare, Omar Aburizaiza, Azhar Siddique, David Carpenter, Mirza M. Hussain, Jahan Zeb, Abdullah Aburiziza, *University at Albany*

This is the first study to assess cardiopulmonary risk from BC, p-SO4^{2-} and p-NO3^{-} exposure in Jeddah. The relative risk (RR) for CVDs and RDs were computed in a single pollutant generalized linear model (GLM) time-series model using moving averages (MAs). Emergency room visits were more frequent than hospitalizations. RDs were highest in younger age-groups with the age-group 0–14 years being the most frequent, while CVD visits were highest in age-groups above 30 years. BC: RDs risk was highest in outpatient females 0–14 years at all MAs; 1.48 (1.04, 2.12) to 2.50 (1.52, 4.11), and males 31–45 years; 1.76 (1.13, 2.73) to 1.90 (1.14, 3.15) at MAs 5–7. CVDs risk was highest in age-group 61–75 years but with marginal statistical significance in both genders. p-SO4^{2-}: RDs risk was highest in males 31–45 years; 1.17 (1.07, 1.29) to 1.26 (1.13, 1.40) at MAs_3–7.

Overall CVDs risk was also highest in age-group 31–45 years; 1.08 (1.00, 1.16) to 1.09 (1.01, 1.18), with higher risk estimates in males; 1.08 (0.99, 1.19) to 1.12 (1.01, 1.24) at MAs 4–7. p-NO3^{-}: No significant risk was observed for RD morbidity. The overall CVDs risk was significant in outpatients age-group 61–75 years at all MAs; 1.204 (1.01, 1.43) to 1.32 (1.10, 1.58); for females, 1.22 (0.99, 1.51) to 1.43 (1.12, 1.82); and for males, 1.21 (1.02, 1.42) to 1.26 (1.05, 1.51).

Elevated levels of air pollutants increased the risk of seeking health care in all age-groups, reflecting the effects of elevated air pollution in Saudi Arabia. Overall, females 0–14 years were more at risk for RD morbidity. CVD morbidity risk was relatively higher in males in age-groups above 30 years.

2HR.14

Point-of-Care Detection of Airborne Respiratory Viruses. AMIN SHIRKHANI, Morteza Alipanah, Matthew D. Jansen, William B. Vass, Sripriya Nannu Shankar, Carlos Manzanas, Mohammad Washeem, Z. Hugh Fan, John Lednicky, Chang-Yu Wu, *University of Miami*

Analytical methods commonly used to detect viruses often yield results too slowly to produce information that is actionable for the protection of individuals exposed during the sampling period. Point-of-care (POC) detection of respiratory viruses collected during air sampling facilitates faster responses for exposure risk mitigation. In this study, we designed and fabricated an adaptor that integrates the air sampler called Viable Virus Aerosol Sampler (VIVAS) with a POC device called Valve-enabled Lysis, paper-based RNA Enrichment, and RNA Amplification Device (VLEAD). This adaptor serves as the sample collector within VIVAS and then interfaces with VLEAD to transfer the virus collection medium after sampling for POC analysis using a ball valve. The adaptor design was initially optimized through computational fluid dynamics modeling, showing a 95% collection efficiency for particles with aerodynamic diameters of 3 µm or larger. Experimental evaluation using an Aerodynamic Particle Sizer confirmed this, indicating an average physical collection efficiency of approximately 94%, consistent with our modeling results. We tested the integrated VIVAS-VLEAD system using lab-generated human coronavirus OC43, which served as a surrogate for SARS-CoV-2. Results indicated 100% success in detecting viruses in samples containing 10^3 to 10^4 genome equivalents (GE) of virus per sample, where concentrations were verified by RT-qPCR. Success in detecting viruses in samples containing 10^2 GE was 33%. Results show that the adapter can effectively collect viruses and transfer them to VLEAD, replacing the standard Petri dish used for collecting aerosol particles in VIVAS. Work reported herein suggests that the VIVAS-VLEAD system can be used for POC virus detection because its limit of detection is comparable to the level at which SARS-CoV-2 has been collected by VIVAS during environmental sampling reported in other studies.

2HR.15

Simulations of Highly Concentrated Droplet Transport and Deposition in an Idealized Mouth-Throat Airway Model. Yu Liu, XIAOLE CHEN, *Nanjing Normal University*

Previous experimental studies have found that the deposition fraction of high-concentfractionn droplets generated by a nebulizer in an idealized mouth-throat model decreases first and then increases with increasing inhalation flow rate. Theoretical analysis suggests that this phenomenon is due to the increased humidity of the inhaled air caused by the evapofractionn of high-concentfractionn droplets, which inhibits further evapofractionn of the droplets. This numerical simulation uses a small number of calculation particles of different diameters to replace actual droplets and calculates the amount of vapor exchanged between the droplets and the environment by multiplying the substitute fraction. Based on the earlier droplet/particle-vapor interaction model, the simulation of the transport and deposition of high-concentfractionn monodispersed droplets generated by a vibrating mesh nebulizer in an idealized mouth-throat airway model was achieved. The deposition fraction of droplets varies with the inhalation flow rate, consistent with experimental results, thus validating the theoretical analysis. The study also analyzed the influence of environmental temperature and humidity on droplet deposition. The results show that the higher the mass fraction of water vapor in the environment, the higher the deposition fraction of droplets in the mouth-throat model, and the larger the average droplet diameter at the outlet.

2HR.17

Determining Medical Nebulizer's Droplet Size Distribution with a Low-Cost Refrigeration System. Taewon Han, Michael Falvo, GEDIMINAS MAINELIS, *Rutgers, The State University of New Jersey*

Medical nebulizers are crucial for respiratory drug delivery and bronchoprovocation testing. Their performance parameters include drug delivery rate and the size distribution of produced droplets. Our study evaluates a high-efficiency breath-actuated nebulizer (AeroEclipse® II BANTM), commonly used to deliver methacholine during bronchial challenge testing to assess airway hyperresponsiveness. In our earlier work, we investigated the nebulizer's drug delivery rate. However, another important parameter of the nebulizer performance – droplet size distribution, is largely unknown. Measuring droplet size distribution is challenging because droplets begin to decrease in size due to evaporation as soon as they leave the nebulizer. Commercially available refrigerated multi-stage impactors alleviate this problem but are prohibitively expensive. We developed a low-cost test system where a nebulizer and an 8-stage Andersen impactor were placed inside a compact refrigerator (1.7 cu. ft.). Tests were performed with NaCl solution with the refrigeration system and at room temperature. The amount of material deposited on filters at different impactor stages was determined by eluting the material and measuring the conductivity of the eluent. Overall, we found that the operational temperature and drug concentration highly affected size distribution. When NaCl 1 mg/mL solution was aerosolized and measured at room temperature, most droplets were smaller than 1.1 µm (73% of collected material). When the same aerosol was measured using the refrigeration system, the size distribution peaked between 1.1 and 4.7 µm (57% of collected material). The all-important PM5 size fraction also differed substantially: it was 47% at room temperature and 70% when using our refrigeration system. The experiments are continuing with different drugs (methacholine) and concentrations (4 and 16 mg/mL). Overall, our developed low-cost refrigeration system and experimental protocol show promise to conveniently and inexpensively determine size distributions of aerosol droplets released by medical nebulizers.

2HR.18

Transmission of Aerosol through Micro-Channel Flow. PHILIP JONES, Samuel Durbin, Adrian Perales, *Sandia National Labs*

The formation of a stress corrosion crack (SCC) in the canister wall of a dry cask storage system (DCSS) has been identified as a potential issue for the long-term storage of spent nuclear fuel. The presence of an SCC in a storage system could represent a through-wall flow path from the canister interior to the environment. Modern, vertical DCSSs are of particular interest due to the commercial practice of using relatively high backfill pressures (up to approximately 800 kPa) in the canister to enhance internal natural convection. This pressure differential offers a comparatively high driving potential for blowdown of any particulates that might be present in the canister. In this study, the rates of gas flow and aerosol transmission of a spent fuel surrogate through an engineered microchannel with dimensions representative of an SCC were evaluated experimentally using coupled mass flow and aerosol analyzers. The microchannel opening diverges linearly from 13 µm on the upstream side to 27 µm on the downstream side. The width and depth are 12.7 mm and 8.89 mm respectively. Both polydisperse and 1-3 micron seed stock of cerium oxide, CeO2, were used as a surrogate aerosols to spent fuel. A pressurized tank containing air or helium was actively seeded with aerosols and allowed to discharge to ambient conditions through the microchannel while aerosol spectrometers measured conditions upstream and downstream of the simulated SCC. These testing efforts serve to better understand the effects of upstream particle size and driving pressure on the transmission of aerosolized spent fuel particles through a SCC during a hypothetical release.

SAND2024-06598A

2HR.19

Understanding the Relationship between Oxidative Potential and Individual Particulate Organic Components in a Residential City of South Korea. SUNG-WON PARK, Ji-Won Jeon, Pyung-rae Kim, Hyo-Won Lee, Soo-Jin Jeong, Yun-seo Lee, Young-Ji Han, *Kangwon National University*

Particulate matter with a diameter of 2.5 micrometers or less ($PM_{2.5}$) is a significant concern for air quality of Northeaste Asia due to its adverse health effects. While the mass concentration of $PM_{2.5}$ is a critical metric, recent research emphasizes the importance of understanding the toxicity of these particles . One key measure of this toxicity is the oxidative potential (OP) of $PM_{2.5}$, which quantifies the capacity to produce reactive oxygen species (ROS). These ROS can induce oxidative stress and inflammation in biological tissues, leading to various adverse health effects, even at low $PM_{2.5}$ mass concentrations.

In this study, antioxidants including ascorbic acid (AA) and reduced glutathione (GSH), and dithiothreitol (DTT) were used to assess the OP of $PM_{2.5}$ collected in Chuncheon, a medium-sized residential city in South Korea. Situated downwind of China and metropolitan areas of Korea, the air quality in this city can be significantly affected by regional- and long-range transport. A previous study found that secondary organic aerosol (SOA) significantly increased during high $PM_{2.5}$ concentration episodes. This study aims to measure the OP of $PM_{2.5}$ during four seasons and to identify the effects of various $PM_{2.5}$ components including ionic, metallic, and 47 individual organic compounds, on OP. During the study period, the average $PM_{2.5}$ concentration was 24.7 ± 15.8 $\mu g\ m^{-3}$, higher in winter and lower in summer. Among organic components, sugar compounds (tracers for biomass burning) and dicarboxylic acids (markers of SOA) were predominant in the total organic matter measured. Additionally, SOA marker species derived from isoprene were observed to be highest in June. Average mass- normalized OP measured by depletion of AA (OP_m^{AA}), GSH (OP_m^{GSH}), and DTT (OP_m^{DTT}) were 2.3 ± 0.4, 1.6 ± 0.7, and 10.2 ± 3.2 pmol $min^{-1}\ mg^{-1}$, respectively. OP_m^{AA} showed significant correlations with saturated fatty acids and sugars, while OP_m^{DTT} correlated significantly with biogenic-SOA tracers. These findings necessitate consideration of individual organic components when evaluating OP. Possible sources for the extrinsic OP were also apportioned by Positive Matric Factorization (PMF) in this study, and the results differed considerably from the source apportionment for $PM_{2.5}$ concentration.

2HR.20

Exposure Studies of Living Organisms: How the PolluRisk Platform is Simulating at the Laboratory Urban Air Quality and Its Health Impacts.

PATRICE COLL, Mathieu Cazaunau, Ambre Delater, Juan Camilo Macias Rodriguez, Lucy Gerard, Aline Gratien, 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, NO2 and O3 (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, SO2, 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 O3, NO2, 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.

2HR.21

Innovative Sampling Methodology for Detecting Viral Aerosols in Exhaled Breath: Enhancing Understanding of Influenza Transmission in Child Care Settings.

ANUBHAV KUMAR DWIVEDI, Emily Hong, Hunter Richards, Zhenyu Ma, Herek L. Clack, Khalil Chedid, Emily Martin, Andrew Hashikawa, Linsey Marr, *University of Michigan*

Introduction
Influenza viruses represent a perennial public health challenge, with their transmission intricately linked to the presence of infectious virus particles. The MITIGATE FLU project, a multi-faceted endeavor, aims to deepen our comprehension of influenza transmission dynamics, integrating laboratory, animal, and human studies. Notably, the human study component focuses on preschool children, aiming to elucidate the relationship between influenza infection incidence and the concentration of influenza viruses in child care center environments, encompassing both surfaces and air, in the region of SE Michigan.

Recognizing the complexity of investigating transmission routes for respiratory viruses, particularly concerning short-range exposure and transmission dynamics, we have devised an innovative sampling methodology specifically tailored for detecting viral aerosols in exhaled breath. This approach addresses the practical challenges inherent in directly collecting breath samples from young children, presenting a novel solution to enhance our ability to identify potential airborne transmission pathways of infectious viruses in child care settings.

Experimental Procedure
Our methodology entails promoting individual children (aged 3-6 years) to use a toy microphone as they talk to, sing to, and make animal noises as prompted by a robotic toy known as Moxie. The microphones have affixed to them a filter cassette via PVC tubing (OD of ⅜”), that is connected to sampling pump (5 LPM), facilitating the collection of exhaled aerosols onto membrane filters, composed of Polytetrafluoroethylene with a 2.0 µm pore size and 37 mm diameter.

Subsequent to sampling, the collected aerosols are subjected to dissolution in an aqueous buffer for downstream analyses. Notably, the efficiency of our sampling method is evaluated using real-time droplet digital polymerase chain reaction (RT-ddPCR), a robust molecular technique enabling accurate quantification of viral load in collected samples.

Validation of our sampling approach involves conducting speaking tests within a controlled clean room environment, wherein expelled aerosol particles generated during speech are sampled and characterized using optical particle counters (OPC) and condensation particle counters (CPC). This validation step ensures the fidelity and efficacy of our methodology in capturing and quantifying aerosolized viral particles, particularly in scenarios mimicking real-world conditions relevant to child care settings.

The successful implementation of our innovative sampling approach holds profound implications for understanding the potential for environmental transmission of respiratory viruses, particularly influenza, in child care environments. By elucidating airborne transmission pathways and identifying periods of heightened virus circulation, our methodology offers invaluable insights to inform targeted infection prevention strategies, ultimately mitigating the burden of respiratory virus infections in child care settings.

2IA.2

The Chemical Transformation and Related Cytotoxicity of Vaping Emissions under the Indoor Atmospheric Aging Process. LINHUI TIAN, Wonsik Woo, Ying-Hsuan Lin, *University of California, Riverside*

E-cigarette emissions, containing various harmful substances, significantly contribute to indoor air pollution and raise concerns about secondary exposure to vaping byproducts. The chemical transformation of e-cigarettes during the vaping process is known to generate new compounds in both the gas and particle phases. While the chemical composition of fresh vaping emissions is well-characterized, the chemical aging products generated by ambient oxidants in the indoor environment are yet to be elucidated. The common flavors in e-liquid are terpenes, which are actively reacted with indoor O3 to chemically age e-cigarette aerosols and produce new oxidation products. In this work, e-liquid mixtures composed of propylene glycol (PG), vegetable glycerin (VG), and terpenes were injected into a 2 m3 FEP chamber. For the aging process of e-cigarette aerosols, 100 ppb O3 was introduced into the chamber, and the reaction lasted for one hour. After aging, more oxidized species, including various carbonyls, organic acids and possible organic peroxides, were observed in aged aerosols, mainly generated from the ozonolysis of terpenes and terpenoids. In addition, the aging process induced an increase in both particle concentration and particle size, as well as their lifetime in the atmosphere of fine particles. Furthermore, we observed that the aged e-cigarette aerosols with a higher degree of oxygenation and a higher potential for particle generation in both concentration and size resulted in greater cytotoxicity through both the lactate dehydrogenase (LDH) cytotoxicity assay and XTT assay. This work highlights the indirect danger of vaping in indoor environments with high ambient oxidant levels and provides a perspective that characterizes second-hand vaping exposure as a significant health risk.

2IA.3

Assessing Secondhand Cannabis Exposure at a Cannabis Consumption Lounge. Muchuan Niu, Yuan Yao, Haoxuan Chen, YIFANG ZHU, *University of California, Los Angeles*

The progressive legalization of recreational cannabis across the United States has fostered a variety of emerging cannabis businesses that include cannabis consumption lounges where customers are allowed to use cannabis in the indoor spaces. However, exposure levels in these unique public spaces have not been documented, and thus, raising concerns about high exposure risks for customers, staffs, and nearby businesses. This study measured secondhand cannabis exposure at a cannabis consumption lounge over a one-week period. The particle decay rate under various ventilation conditions in a cabin was tested to explore potential mitigation strategy. Our results showed that the peak $PM_{2.5}$ (fine particles, diameter ≤ 2.5 µm) during weekdays exceeded 1,500 $\mu g/m^3$ and registered levels over 5,000 $\mu g/m^3$ during the weekends, suggesting extremely high particle exposure within the cabin. The mean cabin $PM_{2.5}$ level (168 ± 237 $\mu g/m^3$) during busy hours (12 pm - 11 pm) were significantly higher than those observed at the lounge backyard (26 ± 45 $\mu g/m^3$) and the street control site (12 ± 4 $\mu g/m^3$). Decay rates were obtained from five ventilating scenarios. After a series of puffs (n = 4), the highest decay rate (27 h^{-1}) was found when the cabin door was opened; while the lowest decay rate (9 h^{-1}) was detected when the air conditioning was turned on, but the door was closed. Nevertheless, particle exposure level after a 5-minute decay remained above the baseline level for all ventilating scenarios. Airborne THC (tetrahydrocannabinol) and nicotine were also collected as tracer chemicals and the results are to be reported.

These findings reveal the high exposure risks in cannabis consumption lounge and highlight the urgent need for regulatory measures to mitigate potential health risks associated with secondhand cannabis exposures in these public indoor settings.

2IA.4

Prescribed Burning Emissions: Impacts on Nearby Residents.

SEAN BENJAMIN, Michael Hannigan, Colleen Reid, Katherine Dickinson, Hannah Brenkert-Smith, Carla Nyquist, Malena Toups, Evan Coffey, *University of Colorado at Boulder*

Wildfires have been a growing threat to residents living in the wildland-urban interface due to a changing climate, societal factors, and land use practices. Prescribed (Rx) burning is a land management technique that can help prevent large and uncontrollable wildfires. A barrier to Rx fire is the impact on nearby residents. Rx fires are often conducted near residential areas to protect those areas from the threat of wildfires in the future. Rx fire practices vary widely and one goal of this work is to explore which of these practices reduce the impact on nearby residents. The emissions from these fires include particulate matter (PM). When inhaled chronically or in large concentrations PM presents a risk to respiratory and cardiovascular health.

In this research, we utilize a suite of low-cost sensors (pods) to investigate the relative impact of Rx fire emissions on nearby residents. Resident exposure to the PM with a diameter of less than 2.5 micrometers (PM 2.5) are determined by analyzing indoor/outdoor ratios in homes within 10 miles of Rx fires. Tracking extraneous indoor emissions sources is critical to isolate the effects of the Rx fires on homes. We do this by having the residents fill out daily activity forms that let us know which spikes could come from the Rx fires. In every field deployment, roughly five pods are deployed per house, three inside and two outside, and these log pollutant concentrations at least once every 10 seconds. This provides us with ample data to analyze the comparison between indoor and outdoor pollutants.

This research aims to provide new information about the potential impacts of Rx burns on nearby residents by analyzing the effects of the Rx burns' emissions on the air quality in and around nearby homes.

2IA.5

Limonene Emission Dynamics of Personal Care Products from Different Surface Materials.

AVISA CHARMCHI, Pascale Lakey, Manabu Shiraiwa, Celia Faiola, *University of California, Irvine*

Volatile organic compounds (VOCs) are important precursors to secondary organic aerosol (SOA) formation. Fragranced personal care products (PCPs) have recently been identified as important contributors to VOC emissions in urban environments, particularly as a source of limonene, which has high SOA mass yields. However, the factors controlling fragranced PCP limonene emissions from various surfaces remain unclear. This research quantified the dynamics of limonene emissions from a variety of different fragranced PCP types and across different types of surface materials. The emission dynamics were measured for 60 minutes at 5-minute intervals from glass, silicone (as a skin proxy), and fabric. The PCP was applied across 34.25 cm^2 of surface. The sample was then placed in a mason jar equipped with bulkhead unions on the lid, flushed with clean air, and samples were collected at the outlet using multi-bed adsorbent cartridges. The samples were analyzed via offline thermal desorption gas chromatography-mass spectrometry (TDGCMS). The results illustrated that limonene emissions from personal care products were more dependent on the surface material than the type of PCP, with silicone (e.g., "skin-like" material) having the slowest emission rate. In addition, we found that "skin-like" material released less mass of limonene across the measurement interval, suggesting that this material serves as a larger sink for limonene. We applied a kinetic multi-layer kinetic model to replicate the measurements, estimating diffusion coefficients of limonene in personal care products to be in the range of 1.5×10^{-9} cm^2s^{-1} – 1×10^{-6} cm^2s^{-1}. The model also demonstrated that the partitioning of limonene into silicone slowed down its evaporative loss to the gas phase. The dynamics of limonene emissions from PCPs could influence indoor air quality as well as urban air quality. Future studies should evaluate the potential impact of these PCP emission rates on human health.

2IA.6

Understanding Contaminant Transmission in Indoor Spaces Considering Real-World Operating Conditions.

ROY KING, Chethani Athukorala, Suresh Dhaniyala, *Clarkson University*

The public health concerns about airborne transmission of germs and pathogens came to the fore during the recent pandemic. That concern also highlighted the importance of HVAC systems in moderating indoor airborne infection spread. With proper design and control, ventilation systems can moderate outdoor pollutant concentrations in indoor spaces and ensure that indoor pollutant concentrations do not build up and contribute to infection spread. Currently, most of our knowledge of the role of ventilation systems in mitigating infection spread is based on simple modeling of fully-mixed spaces. Considering the advances in computational resources available to us, it is now possible to use computational fluid dynamics (CFD) to more accurately characterize the impact of ventilation systems on the fate of aerosol in real-world spaces. In this study, we model the airflow in a large lecture hall considering realistic HVAC operation and compare the numerically obtained fate of carbon dioxide and aerosol particles with experiments in the facility. In this presentation, I will describe our modeling approach and highlight the differences between aerosol fate in real-world built environments compared to idealized fully-mixed spaces and the impact of this difference on infection spread modeling.

2IA.7

Modeling SOA Formation in Indoor Environments: Impact of Lamps, NO2, Ozone, and Wet Inorganic Seed.

Spencer Blau, MYOSEON JANG, *University of Florida*

a-Pinene and toluene are ubiquitous Volatile Compound Products (VCPs) in indoor spaces. In this study, the SOA formation potential from the oxidation of a-pinene bleeding with toluene has been simulated under varying environmental indoor conditions (lamps, NO2, ozone, and inorganic seed) using the UNIfied Partitioning Aerosol Reaction (UNIPAR) model. The UNIPAR-Indoor model utilizes lumping species that originate from explicitly predicted products, produced during the atmospheric oxidation of a precursor hydrocarbon, is employed to process products' multiphase partitioning and aerosol phase reactions. The performance of the UNIPAR model coupled with CB6 was demonstrated using indoor chamber experiments in both the dark conditions and light conditions with commercialized fluorescent lamps or LED lamps. Overall, the model reasonably captured indoor chamber data. The sensitivity of the SOA mass formed under the atmospherically relevant conditions (10 ppb a-pinene with 30 ppb ozone) showed that the formation of SOA from a-pinene in the presence of NO2 with commercialized lamps was slower and lower than that from a-pinene dark ozonolysis. SOA formation significantly increases with increasing NO2 at given conditions. With the high level of NO2 in the dark condition (hydrocarbon ppbC/ NO2 <10), the significant amount of a-pinene SOA is contributed via the reaction with nitrate radicals. With 10 ppb a-pinene, 30 ppb ozone, and 50 ppb of toluene in the dark condition, the simulated sensitivity suggested that 15% of SOA mass of total SOA was contributed by toluene because toluene reacted with OH radicals, which created from the decomposition of ozonolysis products of a-pinene. The impact of wet-seed on a-pinene SOA is negligible, but wet-seed impacted SOA formed from the mix of on a-pinene and toluene increased due to the formation of reactive products from toluene oxidation for oligomerization in aqueous phase. We conclude that ozone and NO2, intruded from outdoor environments effectively oxidized terpene and furthermore aromatic hydrocarbons with the OH radical originating from ozonolysis of terpenes in both the dark and indoor lamp conditions. Overall, the dark reaction paths with ozone and radicals are more effective to form SOA than light conditions with commercialized lamps in indoor environments.

2IA.8

Indoor Dynamics of Ionic PFAS: Results from the IPA Campaign.

Naomi Chang, Clara Eichler, Daniel Amparo, Elaine Cohen Hubal, Jason Surratt, Glenn Morrison, BARBARA TURPIN, *UNC-Chapel Hill*

Per- and polyfluoroalkyl substances (PFAS) are persistent, bioaccumulative, and present in many consumer products. Some have been associated with adverse health effects like hepatotoxicity and reduced immune response in children. People spend roughly 90% of their time indoors, which is an important place for exposure. However, few concurrent measurements from multiple environmental compartments within homes exist. As part of the UNC Indoor PFAS Assessment (IPA) Campaign, we sampled air ($PM_{2.5}$ quartz fiber filters; QFF), dust, water, indoor window surfaces, wall-mounted glass slabs, and heating and air conditioning (HAC) filters for 26 ionic PFAS using an AB Sciex Triple Quad (UHPLC-ESI-MS/MS) in 10 homes in North Carolina over 9-months. We compare PFAS species profiles and time series across compartments to develop hypotheses about PFAS sources, dynamics, and chemistry. We use multicompartment measurements to gain insights regarding using HAC filters or windows as convenient indoor PFAS samplers and compare with insights from concurrently measured neutral PFAS. Ionic PFAS were detected in all compartments. On QFFs, which collect particles and some adsorbed vapor, mean PFBA concentrations were highest (12.2 pg m^{-3}; DF = 67%), while PFHxA, PFOA, and PFOS had the highest detection frequency (DF = 80%; medians = 0.5-0.7 pg m^{-3}). Substantial differences were observed between ionic PFAS on glass slabs and windows, which are subject to greater and more variable temperature gradients and sunlight. The ionic PFAS species profile for HAC filters was strongly ($R^2 = 0.91$) and significantly ($p < 0.05$) linearly associated with a combination of dust ($\beta = 0.6$) and QFF-collected $PM_{2.5}$ ($\beta = 0.1$), whereas the pattern of neutral PFAS on HAC filters was predominantly explained by dust.

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.

2IA.9

Effect of Poor Outdoor Air Quality and HVAC Settings on Indoor Air Quality on the University of Utah Campus.

TRISTALEE MANGIN, Kerry Kelly, Darrah Sleeth, Dillon Tang, Zachary Palmer, Zachary Barrett, Sean Nielson, *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. This study aims to understand the impact of pollution episodes (wildfire smoke, dust events, and temperature inversions) on indoor air quality using a network of low-cost air quality sensors on a university campus and to identify the effect of HVAC operations on IAQ.

This study deployed 21 low-cost air quality sensor nodes measuring PM2.5 and carbon dioxide (CO2) levels, with 17 sensors at indoor locations and four sensors at two outdoor locations across the University of Utah campus. We developed a dashboard to share the AQ measurements in real time with facilities management. The sensors were deployed in November 2022 and continue to operate. We identified the following outdoor pollution events: four temperature inversion events (when the valley heat deficit values exceeded 4.04 MJ/m2 for three or more days), 10 dust events (when the regulatory PM10 concentrations exceeded 100 ug/m3 with a wind speed greater than 5 m/s), and two wildfire smoke events (using the aerosol optical depth results from NASA WorldView satellite images). The University of Utah facilities management has provided access to the HVAC settings and equipment measurements for these pollution episodes.

Wildfire smoke has the largest impact on IAQ of the three pollution events studied. These events had the highest indoor-to-outdoor PM2.5 correlation with an R2 value of 0.68, while inversion and dust events had indoor-to-outdoor correlation values of 0.32 and 0.44, respectively. The wildfire smoke events resulted in the highest hourly average PM2.5 concentrations for 12 of the 17 indoor locations compared to inversion and dust events. During the wildfire events, 9 locations exceeded World Health Organization 24-hour PM2.5 concentration guidelines for a total of 13 days, with a maximum hourly PM2.5 concentration of 37.4 ug/m3. This is a surprising finding, given that many of the buildings are equipped with MERV13 filters, which have an efficiency rating of >50% for PM ranging from 0.3 – 1 um and >85% for PM ranging from 1 – 3 um, both of which are associated with wildfire events. Preliminary HVAC analysis indicates that HVAC operations impact IAQ during pollution events. For example, the team found one location where an open outdoor damper resulted in an increase in the indoor-to-outdoor PM2.5 concentration ratio from 0.33 to 0.79. Further analysis of HVAC operations is underway for the additional locations and different pollution events.

2IA.10

Real-Time Detection of Narcotics and Explosives Using Single-Particle Mass Spectrometry. JOHANNES PASSIG, Marco Schmidt, Haseeb Hakkim, Aleksandrs Kalamasnikovs, Petra Hehet, Ellen Iva Rosewig, Guanzhong Wang, Heinrich Ruser, Michael Pütz, Martin Seipenbusch, Simone Vinati, Karsten Wegner, Thorsten Streibel, Robert Irsig, Andreas Walte, Sven Ehlert, Ralf Zimmermann, *Mass Spectrometry Centre;Rostock University/Helmholtz Munich*

Beyond air pollution, dangerous dusts pose significant risks to human health and safety, e.g. from accidental releases of hazardous substances or during the illegal transport and handling of drugs. The current opioid crisis in the U.S. has highlighted the lack of technologies that can detect such dusts in real-time. We developed an approach to address this gap. It includes (I) pulsed particle resuspension, (II) aerosol concentration, (III) SPMS detection, and (IV) real-time pattern recognition using machine learning.

The core detection technology of our approach is Single-Particle Mass Spectrometry (SPMS), which is capable of chemically characterizing individual particles in a complex aerosol (Pratt and Prather, 2012). Following the introduction of resonant ionization methods for particle-bound metals (Passig et al. 2020) and polycyclic aro-matic hydrocarbons (Passig et al. 2022), we are ready to tailor the SPMS technology to dusts of various drugs and explosives. We present the resulting single-particle mass spectra of drugs and show how interferences with other particle types in a complex environment can be overcome.

We developed a sampling system for the modified SPMS including particle redispersion using gas pulses and aerosol enrichment for direct sampling from contaminated surfaces. The results include measurements conducted at the DHL hub in Leipzig, where packages containing drugs could be identified using this technology. Furthermore, experiments in a former illegal drug lab demonstrated real-time detection of drug and tablet residues on contaminated surfaces and floors.

To realize the online screening of hazardous particles and real-time risk assessment, we develop real-time soft-ware, including preprocessing, screening, clustering, and machine learning. We explored supervised learning for particle screening and classification and show that they can outperform traditional unsupervised algorithms like ART-2a clustering in terms of speed and accuracy, facilitating real-time data analysis and immediate emergency response (Wang et al., 2024).

2IA.11

Unveiling the Hidden: Affordable Particles Plus Water-based CPC Explores Ultrafine Particles in Office Buildings with Central HEPA Filtration. ANIL NAMDEO, Adam Giandomenico, *Northumbria University and Particles Plus Inc.*

High Efficiency Particulate Air (HEPA) filtration systems are often seen as the gold standard for indoor air quality. However, their effectiveness can be deceptive when it comes to Ultra Fine Particles (UFPs). This study explores the ability of affordable Particles Plus Condensation Particle Counter (CPC) 15000-OEM, to detect the presence of UFPs in office environments equipped with HEPA filtration.

The paper highlights how human activities within an office building can generate UFPs, particles small enough to bypass HEPA filters and potentially compromise indoor air quality. By utilizing affordable CPC technology, the research demonstrates a cost-effective method for uncovering this hidden threat. This newfound awareness can empower building managers to take appropriate actions to ensure a truly healthy workplace environment.

It is clear from the measurements that during high occupancy and traffic in certain rooms and activities, the number of UFPs rises exponentially. Restroom activities can pose a severe impact on indoor air quality as the flushing of water in the toilets generates a lot of nanoparticles that can linger for a longer time in the breathable air, but when the occupants close the restroom door the surroundings rooms are safer.

The evaluation measurements started on April 2024 and ended on May 2024. The sampling site is Particles Plus headquarters (42.1317301, -71.125625) in a suburban area south of Boston. Although the measurements were taken in a suburban area, the roads around the building experience high traffic from heavy duty internal combustion engine (ICE) vehicles. Indoor relative humidity was below 40% indoors and around 50% outdoors.

The instrument was in operation to acquire the total particle number of aerosols in the size range from 5 to 3000 nm.

This work was supported by the Particles Plus, Inc. internal funding.

2IA.13

Effects of Germicidal Far-UVC on Indoor Air Quality in an Office Setting. ZIFENG TANG, Farideh Hosseini Narouei, Shiqi Ian Wang, Raabia Hashmi, Sandhya Sethuraman, David Welch, David Brenner, V. Faye McNeill, *Columbia University*

The application of 222 nm light from KrCl excimer lamps (GUV222 or Far-UVC) is a promising approach to reduce the indoor transmission of airborne pathogens, including the SARS-CoV-2 virus. GUV222 inactivates airborne pathogens and is believed to be relatively safe for human skin and eye exposure. However, UV light initiates photochemical reactions which may negatively impact indoor air quality. We conducted a series of experiments to assess the formation of ozone (O3) and secondary organic aerosols (SOA) induced by commercial GUV222 devices in an office environment. We find that a single GUV222 lamp (room average 0.29 mW cm^{-2}, 1.65 mW cm^{-2} at sampling location) does not significantly impact O_3 or fine particulate matter levels. Higher GUV222 fluence (room average 1.16 mW cm-2) leads to increases in O_3 up to 10 ppb above background, and minor increases in particulate matter. The use of GUV222 at low intensities and in conjunction with adequate ventilation may reduce airborne pathogen levels while minimizing the formation of air pollutants.

2IA.14

Investigating the Transport of Fine Particulate Matter from a Point-Source in a Multi-Story House with Different Modeling Approaches. Andrew Martin, Stephen Zimmerman, Liora Mael, Dustin Poppendieck, Delphine K. Farmer, MARINA VANCE, *University of Colorado Boulder*

This work investigates the transport of fine particulate matter ($PM_{2.5}$) in a multi-story test house using cooking emissions as a point source. The test house was outfitted with 13 PurpleAir $PM_{2.5}$ monitors, and particle sources included cooking (pan cooking and air frying) as well as ambient $PM_{2.5}$ penetration into the house during periods of no indoor activity. We then compared three different modeling approaches to predict $PM_{2.5}$ concentrations throughout the house: a box model, an empirical model, and the NIST CONTAM simulation tool. In the absence of indoor sources, we observed about 10 % of ambient PM2.5 concentrations penetrated indoors with a time lag of about 1 h. Similar peak $PM_{2.5}$ concentrations were observed for pan frying and air frying using the same ingredients. A cross-correlation analysis showed that it took 2 to 4 minutes for kitchen peak concentrations to reach other sensors on the first floor and about 8 minutes to the second floor. $PM_{2.5}$ concentrations were heterogeneous on the first floor, with peak concentrations reaching 45 ± 9 % relative to the kitchen. Concentrations on the second floor were much more homogeneous with concentration peaks reaching 18 ± 2 % relative to the kitchen. The highest $PM_{2.5}$ exposure was experienced in the kitchen/dining area, accounting for 9 % of the time spent at home and 44 % of the $PM_{2.5}$ exposure.

2IA.15

3D Printed Microscale Cyclones Enabling High-Efficiency Collection, Separation, and Recovery of Sub-Micrometer Aerosol Particles. PROMA BHATTACHARYA, Dewansh Rastogi, Sima Mehraji, Akua Asa-Awuku, Don L. DeVoe, *University of Maryland*

The collection and separation of aerosols is essential for capturing and investigating particulate matter because of the effects it has on human health. Sub-micron particles are of most concern because of their ability to deeply infiltrate the lungs, leading to different respiratory and cardiovascular diseases(Chen et al. 2021). Capturing these particles are more challenging at low flow rates, and we aim towards that goal.

In this work, we have fabricated geometrically similar microcyclones by using a high-resolution stereolithographic 3D printer using an acrylic-based resin, at different size scales. These 3D printed cyclonic devices are capable of highly effective particulate matter separation and collection with well-defined cutoff sizes. Particulates as low at 50 nm were captured with excellent cut sharpness at an air flow rate of 5 L/min using our smallest device with a minimum channel dimension of 0.75 mm. A key advantage of this platform is the low internal volume of the cyclone chamber, which allows for the recovery of fractionated samples from the enclosed cyclone chamber through rapid rinsing with a small volume of elution buffer. This feature enables collected particulates to be recovered with minimal dilution for increased sample concentration during downstream analysis of captured particles. Moreover, the pressure drop across these devices is low, facilitating its use in personal air sampling to be used with common miniature diaphragm air pumps.

The high capture efficiency for submicron particles, compact form factor, effective sample recovery, tunable cut size, and cost-effective manufacture make the microcyclone platform a promising tool for various applications in particulate matter and aerosol science, including environmental and personal air sampling.

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2IA.16

Particulate Air Pollution from Secondhand Cannabis Smoke in Public Venues. XIAOCHEN TANG, Abel Huang, Morgan Murphy, Marion Russell, Suzaynn Schick, Hugo Destaillats, *Lawrence Berkeley National Laboratory*

Secondhand cannabis smoke poses a growing public health concern, partly associated with the rapidly changing legal status of cannabis in the US. Many states now permit cannabis consumption in designated stores and at certain events, on licensed buses and in hotels, restaurants, and other venues. This can create exposure risks for employees, event attendees, customers and the public. This study aims to measure the particulate air pollution caused by cannabis use in public places in the US, and to assess secondhand exposures of nonsmokers.

PM2.5 samples from secondhand cannabis emissions were collected in 1) a cannabis dispensary with a lounge where dabbing and vaporizing were allowed, but not smoking, 2) a cannabis dispensary with a lounge where smoking, dabbing and vaporizing were allowed, and 3) a cannabis festival in a large hall where smoking, dabbing and vaporizing were allowed. Background samples were collected at a nearby outdoor locations where cannabis was not being consumed.

Collected sample filters were cut to halves and weighed before solvent extraction and sonication. For PAH analysis, one half was extracted with a 50:50 acetone:hexane mixture with sonicated for 30 minutes, while for THC analysis using methanol as the solvent. The extracts were analyzed by gas chromatography/mass spectrometry (GC/MS, Agilent 5977). Spiking recovery tests suggested 60-100% extraction efficiency with this method.

Comparison of total PAH concentrations (µg m-3) corresponding to background and air samples collected at one cannabis festival and one cannabis dispensary lounge clearly show that cannabis consumption in these venues results in elevated PAH levels in indoor air. Most of the 22 PAHs were detected at levels above the limit of quantification of 3 pg per filter. The determination of THC concentration in the same samples will allow us to determine normalized compound-specific emission rates for individual PAHs.

2IM.1

Using Machine Learning Models to Enhance Chemical Characterization from TOF-ACSM Mass Spectra.

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

Characterizing organic aerosols is critical in understanding atmospheric processes that affect climate change, air quality, and human health. Time of Flight Aerosol Chemical Speciation Monitor (ToF-ACSM) has been utilized to quantify inorganic and organic aerosols with high time resolution for a decade. However, the combined effects of thermal decomposition and fragmentation from electron ionization interfere with organic (OA) composition characterization. Estimating functional groups, like carboxylic acids and alcohols, from ToF-ACSM mass spectra remains challenging. The ToF-ACSM organic characterization will be enhanced by qualitatively exploring the relationship between ACSM fragment ions and fractions of functional groups (acids and alcohols) present in various representative compounds and assessing what type of model might best be used for prediction. Here, we systematically explore the relationships between fragment ions (m/z 29, 43, 44, 55, 57, 60, 69, 71, 73) from individual compounds, lab-generated mixtures, and their functional groups (acid mass fraction and OH mass fraction) by statistical models (Partial Least Square Regression, PLSR) and machine learning techniques (Random forest, RF, and Support Vector Machine, SVM). We selected a wide range of chemical representatives of carboxylic acids, alcohols, and multi-functional compounds with different O:C and sources, for instance, hydrocarbon-like OA, biomass-burning OA, cooking OA, and oxidized OA, including 22 pure compounds and 20 lab-generated mixtures. The fragment ions from lab-generated mixtures are used as the test set to evaluate predictions of acid or OH mass fractions made by mathematical mixtures from single compounds in three models. Overall, the OH mass fraction is better predicted than the acid mass fraction, and the RF model shows better prediction metrics (R^2, bias, errors, etc.) than other models.

2IM.2

Improvements in Portable Gas Chromatography-Mass Spectrometry for Volatile Organic Compounds Detection.

SABIN KASPAROGLU, Anthony S. Wexler, *University of California, Davis*

Air pollution causes significant health problems and environmental concerns. Small atmospheric particles and toxic volatile organic compounds (VOCs) serve as key contributors to air pollution. These pollutants affect human health, wildlife, and vegetation. VOCs have diverse origins, releasing from both natural sources such as wildfires and vegetation as well as anthropogenic sources, including vehicle emissions, the burning of fossil fuels, and heavy industrial processes. Recognizing the severity of this issue, the US Environmental Protection Agency has identified over 180 compounds as hazardous air pollutants, the majority of which are VOC, requiring monitoring to protect public health and the environment. Thus, determining the air pollutants to which populations and vegetation are exposed is a primary concern. One significant consequence of VOCs is observed in the wine industry, known as smoke taint. Volatile phenols released from wildfires can deposit on the grapes in vineyards causing an undesirable taste in the wine, which cannot be detected before the fermentation process. A common analytical method for measuring VOCs is gas chromatography-mass spectrometry (GC/MS), which can detect and quantify VOCs in both indoor and outdoor environments. This method can separate identical molecules by their volatility and mass-to-ion ratio. In this work, we will demonstrate our progress in developing a low-cost, lightweight, battery-powered portable GC/MS intended to be more accessible to a broader audience, and for this application can be deployed in the field to assess phenols in wine grapes and in wildfire smoke. Additionally, we will show smoke taint analysis in grape samples exposed to controlled combustion emissions for early detection of volatile phenol by using our portable GC/MS.

2IM.3

Analytical Method for Quantification of Airborne Respirable Crystalline Silica Using Raman Spectroscopy. VASILEIA VOGIAZI, Chen Wang, Pramod Kulkarni, *Centers for Disease Control and Prevention, NIOSH*

Inhalation exposure to crystalline silica aerosol poses significant health risks in many workplaces. There is a need for laboratory analytical methods as well field-portable methods for onsite analysis of trace level exposures, capable of measuring a few µg/m3. To address these needs, a standardized method using a portable probe-based Raman and an analytical confocal Raman microscope has been developed for the measurement of trace quantities of airborne respirable crystalline silica (RCS). This method is particularly useful to quantify trace level RCS exposures that can't be achieved with X-ray Diffraction (XRD) or Infrared (IR) methods. The method implements a microconcentration technique with point-measurement as well as a rastering scheme that covers a large sample spot area and provides detection limits much below the RCS exposure limit of 50 µg/m3. The method can quantify both α-quartz and cristobalite polymorphs in the range of 2 (± 0.1) - 50 (±2.8) µg per filter using point-measurement with a field-portable probe-based Raman spectrometer. The relative standard deviation of the probe-based method is in the range of 1-11%. Using a rastering scheme with a confocal Raman microscope the limit of detection as low as 0.1 µg could be achieved. Relative standard deviations of triplicate measurements were in the range 10-23% and the limit of quantification was estimated to be 0.5 (± 0.08) µg RCS per filter. The uncertainty of the method was better than that of the XRD method (NIOSH method 7500). The potential interferent materials, such as iron oxide and TiO2, can affect the quantification and measurement uncertainty, particularly at trace concentrations of RCS. The method is currently being extended to quantify RCS in field samples; the results will be compared with XRD measurements.

2IM.4

A Data Analysis Pipeline for Identification of Untargeted GC-EI-MS Spectra. DEBORAH F. MCGLYNN, Lindsay Yee, Lewis Geer, Yuri Mirokhin, Dmitrii Tchekhovskoi, Coty Jen, Allen Goldstein, Anthony J. Kearsley, Stephen E. Stein, *National Institute of Standards and Technology*

Despite the thousands of compounds represented in mass spectral (MS) libraries, a large fraction of spectra in complex mixtures cannot be identified. Environmentally sampled compounds pose a special challenge, as these compounds are commonly subjected to complex chemical reactions such as oxidation or pyrolysis. While matching chromatographic retention index data improves the confidence of any spectral identification, this information is not always available and typically requires significant manual effort to be incorporated in the analysis. In this work, we present a search method that considers MS similarity, retention indices, and molecular mass when scoring library matches. When retention indices are not available, AI-estimated values are provided. The new method was applied to a MS dataset containing 4833 Trimethylsilyl (TMS)-derivatized spectra collected by the University of California at Berkeley of particulate organic compounds emitted by wildland fires. The dataset was run against the NIST 2023 EI-MS dataset using the identity search method with retention index penalization. The RI threshold window used was ± 25 between the unknown and the library spectra. Based on NIST23 library matching, this analysis led to 181 new identifications in the dataset. 105 identities from previous work were confirmed while 34 previous IDs were changed. Following this, estimations of molecular mass were made for MS with high signal to noise ratios. This allowed the library-based 'hybrid' search method to be used to identify compounds similar to, but not present in, libraries. These new methods increase reproducibility, reduce analysis time, and increase identification frequency in these complex mixtures. Since the number of remaining unidentified spectra remains large (4530 spectra), this work concludes by identifying which spectra are most likely to be identified by additions to libraries or further analysis, and which are most likely to remain unidentifiable due to possible contamination or low signal strength.

2IM.5

Characterizing Metal Particles Emitted from Aircraft Engines.

BENJAMIN A. NAULT, Peter F. DeCarlo, Richard Miake-Lye, Edward Fortner, Richard Moore, Steven Baughcum, *Johns Hopkins University*

The volatile and non-volatile particles emitted from aircraft engines have been an area of intensive research. For the non-volatile particles, this component has been typically associated with soot/black carbon. Metals could possibly be another component of the non-volatile particles; however, these metals have not been as well characterized during aircraft emission studies. Characterization of what types of metal particles are emitted from aircraft engines due to regular operations and wear and tear is needed to help evaluate their air quality impact near airports. Here, we use a combination of in-situ (soot particle high-resolution time-of-flight aerosol mass spectrometer) and off-line (transmission electron microscopy and other microscopy techniques) to characterize the metal particles directly emitted from aircraft engines without the influence of metal particle emissions associated with take-off and landing (e.g., tire wear and brakes). These observations will span different aircraft engine studies to potentially differentiate different metal particles from different engines and/or engine operating conditions. Initial analysis of the in-situ observations indicate the potential importance of titanium, iron, and potentially zinc emissions from aircraft engine operations.

2IM.6

Exposure to Crystalline Silica Nanoparticles during Fabrication of Natural and Engineered Stones.

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

Inhalation exposure to airborne respirable crystalline silica (RCS) during the fabrication of construction products such as engineered and natural stone-based kitchen countertops has been on the rise globally in recent years. The disease burden from RCS exposure is well documented; however, little is known about the abundance of crystalline form of silica in the nanoparticle or sub-100 nm fraction and its implication on health effects. The nanoparticles have longer settling times, higher surface area per unit mass, greater probability of depositing in the alveolar region and can present greater health risks if they are abundant in the RCS fraction. In this study, we report on the fractional silica content in the sub-100 nm and respirable aerosol during grinding/cutting/drilling of natural and engineered stones in laboratory wind tunnel experiments. The crystalline silica content was determined through X-ray diffraction (XRD) and Raman spectroscopic analysis. The presence of the crystalline phase of silica in the sub-100 nm fraction was further confirmed by electron diffraction analysis in transmission electron micrographs. For the aerosol generated during the grinding of a commercial engineered stone, the sub-100 nm fraction accounted for 0.5 % of the aerosol mass, whereas it accounted for 27 % of the aerosol surface area based on total lung deposition. To better understand exposure, the relative amount of silica in the respirable and sub-100 nm compared to the bulk crystalline silica fraction in the stones during different fabrication processes will be presented. The efficacy of nanoparticle removal by simple engineering controls during fabrication will be discussed.

2IM.7

Organic Nitrogen Ions in Aerosol Mass Spectrometry and Implications for Source Apportionment and Understanding SOA Chemical Processing. JUSTIN TROUSDELL, Christopher Niedek, Weiqi Xu, Yele Sun, Xinlei Ge, Qi Zhang, *University of California, Davis*

The identification and utility of organic nitrogen (OrgN) ions detected in the mass spectra of high-resolution aerosol mass spectrometers (HR-AMS) has not been fully explored. Although the AMS spectral features of organic nitrates (ON), a subset of OrgN, have received significant attention, other OrgN fragments are often overlooked due to measurement uncertainties, resulting in lost information. Since the HR-AMS remains the standard instrument for quantitative fine-mode aerosol compositional measurements, it is important to leverage the technology and optimize its analysis potential. A recent study in our lab has demonstrated the possibility of accurately determining OrgN ions using HR-AMS (Ge et al., 2023). Building on this research, we applied positive matrix factorization (PMF) on a combined matrix of the mass spectra of 75 OrgN standards previously collected with the HR-AMS, and thereby correlated $C_xH_yN_z^+$ and $C_xH_yN_zO_p^+$ fragments with specific OrgN functional groups. These findings are then interpreted alongside the fitted OrgN ions from ambient datasets. We also conducted PMF only on the OrgN ions (OrgN-PMF) in addition to regular PMF as part of our explorations. Comparing the results between the OrgN-PMF and regular PMF demonstrates that OrgN ions carry important information and can provide additional insight into organic aerosol (OA) sources and processing. The ambient data consistently demonstrated that both primary and secondary OA spectra contain $C_xH_yN_z^+$ and $C_xH_yN_zO_p^+$ ions. However, secondary sources are dominated by smaller OrgN fragments (C_{1-2}), whereas primary sources exhibit larger fragments (C_{3-6}). SOA are notably enriched in $CH_{0-4}NO^+$ ions, particularly $CHNO^+$, indicating an enhancement of compounds containing amide (-NH-C(=O)-) functional groups.

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2IM.8

Chemical Characterization of Aerosol Droplets via Droplet Assisted Ionization Mass Spectrometry. JOSHUA HARRISON, Thomas Hilditch, Kelvin Risby, Jim Walker, Bryan R. Bzdek, *University of Bristol*

Droplet assisted ionization (DAI) is a voltage-free approach to create molecular ions from aerosol droplets for mass spectrometry analysis. This approach enables online, sensitive detection of analytes in aerosol droplets. The ionization mechanism for this method remains not fully understood. The role of water content was explored by sampling aqueous submicron aerosol into the customized inlet of a SYNAPT XS time-of-flight spectrometer. Aerosol number and mass concentrations were measured using a scanning mobility particle sizer. The droplet water content was controlled by changing the relative humidity (RH) around the aerosol either with a Nafion dryer to dry liquid droplets, a water boat to humidify dry particles, or a condensational growth chamber, activating the aerosol into supermicron liquid droplets. is important in the ionisation process, yielding a higher ion yield when more water, a protic solvent, is present. 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. Different analytes exhibited different RH-dependent ion yields that were consistent with each analyte's hygroscopic response. For the ion yield of cortisol, a non-hygroscopic compound, there was no dependence on RH, whereas for angiotensin II, a mildly hygroscopic peptide compound, a clear increase (~2 orders of magnitude) at high RH compared to dry conditions was observed. Ammonium sulfate, 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. Mixtures of analytes in aerosol droplets convolute this understanding. Using the scanning mobility particle sizer, size-resolved ion yields were determined, indicating size-dependency of ionization efficiency. Furthermore, DAI was used to validate observed accelerated chemical reaction kinetics in the aerosol phase.

2IM.9

Design and Development of a Field-Portable Tandem Raman and Elemental Aerosol Spectrometer (TREAS) for Near Real-time Aerosol Measurement.

Nicholas Pugh, ORTHODOXIA ZERVAKI, Kabir Rishi, Pramod Kulkarni, *Centers for Disease Control and Prevention, NIOSH*

We present design and development of a hand-portable, battery-operated Tandem Raman and Elemental Aerosol Spectrometer (TREAS) for the near real-time quantification of atomic and molecular speciation of workplace aerosols. The instrument uses an automated cyclical “collect-analyze-ablate” scheme, where aerosol is first sampled onto a rotating electrode as a dry spot sample, followed by its non-destructive molecular analysis using laser Raman Spectroscopy (RS). The dry spot sample is then ablated by a series of pulsed spark plasma discharges and the elemental quantification is obtained using spark emission spectroscopy (SES). The scheme allows time resolution of a few to several minutes. Laboratory experiments were conducted to evaluate the instrument’s time-resolution, limits of detection (LODs), uncertainty, and dynamic range for common workplace aerosols such as respirable crystalline silica (RCS) and titanium dioxide (TiO_2). The mass LODs for RCS were approximately 306 (±14) ng, and 88 (±11) ng using RS and SES, respectively, while for TiO_2, they were 10 (±0.4) ng, and 28 (±2) ng using RS and SES, respectively. These LODs were lower than those achieved by the standardized X-ray diffraction method (3-10 µg) for particulate samples. Ability of TREAS to speciate α-quartz and rutile TiO_2, even in the presence of interferants like those found in fracking sand dust and aerosols generated during the grinding of engineered stone countertops, was assessed using laboratory test aerosols. The tandem molecular and atomic emission measurements in TREAS can allow both elemental identification and differentiation between different oxidation states, such as chromium (VI and III) in welding fumes. The ability of TREAS to measure in near-real time was demonstrated by continuously measuring transient aerosol concentrations. The study demonstrates the potential of TREAS to offer on-site, near real-time quantification with high specificity and sensitivity for many occupationally relevant aerosols.

2IM.10

Quantifying the Contributions from Multiply Charged Particles to Improve Calibration Procedures for the ACSM.

Ernie R. Lewis, Arthur J. Sedlacek, Ogochukwu Enekwizu, Maria Zawadowicz, AMIE DOBRACKI, *Brookhaven National Laboratory*

The Aerosol Chemical Speciation Monitor (ACSM, Aerodyne Inc.) measures non-refractory submicron aerosol mass concentrations. Calibration of the ACSM typically involves aerosolizing an ammonium nitrate solution and selecting particles with a 300 nm electrical mobility diameter using a differential mobility analyzer (DMA). It is commonly reported that there is minimal contribution from multiply charged particles of the same diameter when an ammonium nitrate solution with a concentration between 0.005 and 0.018 M is used. However, at these conditions, our findings reveal that these multiply charged particles contribute between 20-40 % of the measured nitrate mass. To address the contribution from multiply charged particles, we employed a Centrifugal Particle Mass Analyzer (CPMA; Cambustion) in conjunction with the DMA to isolate singly charged particles based on both their electrical mobility diameter and mass. Our results reveal that the ACSM sampling efficiency at electrical mobility diameters of 100, 200, and 400 nm is substantially less than 100 % when both the DMA and CPMA are used, based on a sampling efficiency of 100 % for ammonium nitrate particles selected only by the DMA at 300 nm electrical mobility diameter. We propose a simple protocol for correcting the bias introduced by multiply charged particles during laboratory experiments and field measurements when a CPMA is not available.

2IM.11

Monitoring and Diagnostic Tools for Aerosol Beams from Different Aerodynamic Lenses. DONGWOOK KIM, Pedro Campuzano-Jost, Hongyu Guo, Leah Williams, Philip Croteau, John Jayne, Douglas Worsnop, Jose-Luis Jimenez, *University of Colorado, Boulder*

An aerodynamic lens (ADL) (Liu et al., AS&T, 1995) consists of multiple constrictions in series and is used to collimate aerosol into a narrow beam, enabling its efficient transmission into an aerosol detection region while greatly reducing the gas-phase background. ADLs are widely used as inlets in real-time aerosol measurements with mass spectrometry. Depending on the design, an ADL transmits different size ranges of aerosols and focuses them differently. The aerosol transmission efficiency of an instrument with an ADL inlet can be affected by the focusing/pointing characteristics of an ADL. Here we introduce techniques to monitor the beam center positions and beam widths of an aerosol beam as a function of vacuum aerodynamic diameter using an Aerodyne aerosol mass spectrometer (AMS) and customized 2D beam width probe. Based on the information obtained from the beam measurements, we estimate the aerosol transmission efficiency using a simple aerosol beam dispersion model. Model results were consistent with measured aerosol transmission efficiency and particle deposition pattern images. These tools can be used to characterize different ADLs, estimate and optimize the particle transmission efficiency of an AMS, and monitor the stability of the focusing performance over time. We will present an example of inlet diagnostics using those tools and optimization of lens alignment to maximize particle transmission efficiency.

2IM.12

Contrasting the Composition of Urban and Remote Fine Aerosols Using Single Particle Inductively Coupled Plasma Time-of-Flight Mass Spectrometry. PATRICK HAYES, Kevin Wilkinson, James King, Yannick Tardif, Léa Richard, Daniel Bellamy, Alisée Dourlent, Nicole Trieu, Katia Iatariene, Houssame-Eddine Ahabchane, *Universite de Montreal*

Elevated concentrations of fine particulate matter (PM) are associated with poor air quality and a variety of adverse health effects. However, the variety of single particle techniques available for elemental analysis of fine particles is limited. In this work, $PM_{2.5}$ samples were collected and extracted into water from polycarbonate filtration membranes (Nuclepore). The elemental composition of the extracted particles was then determined using single particle inductively coupled plasma time-of-flight mass spectrometry (SP ICP-ToF-MS), which was applied to compare the composition of urban fine PM (Montreal, QC, Canada) and fine PM collected from a remote high latitude region impacted by local mineral dust (Kluane Lake, YT, Canada). Hierarchical clustering was used to classify the different types of PM and better determine their atmospheric origin. Clusters of particles containing Fe, Si, Al, SiAl, AlFe, TiFe, SiMgAl, Ce and Cr have been identified in both locations, although the abundance of some of these clusters are different between the two locations. Most notably, Fe-containing particles, likely iron oxides, were the largest particle type by number concentration at the remote site. Whereas, Ti-containing particles, likely titanium dioxide, were the largest type by number concentration at the urban site. Furthermore, greater quantities of trace elements like Pb and Cr were observed at the urban site, either as the predominant component within the particle, or as a minor constituent in or on a particle containing natural major elements. The presentation will discuss the potential new applications of SP ICP-ToF-MS for source apportionment of metals and metalloids in fine PM using the results from the two field sites.

2IM.13

Enhancing the Measurement Accuracy of Integrated Photoacoustic Nephelometers to Better Characterize Infrared Optical Properties of Stratospheric Aerosol Injection Candidates.

PRABHAV UPADHYAY, Taveen Kapoor, Benjamin Sumlin, Rajan K. Chakrabarty, *Washington University in St. Louis*

Stratospheric Aerosol Injection (SAI) is a geoengineering technique aimed at counteracting rising global temperatures by introducing sunlight-reflecting aerosols into the stratosphere to reduce global albedo. Ideally, SAI materials should not absorb shortwave solar and longwave terrestrial radiation (200-4000 nm) that can potentially heat the stratosphere. To constrain the types of suitable candidate SAI materials, the optical properties must be fully understood through laboratory measurements of their scattering and absorption behaviors. One instrument capable of this task is the integrated photoacoustic-nephelometer (IPN), which simultaneously measures these parameters. Improving the sensitivity and reducing the noise of near-IR IPN measurements is vital for providing accurate data to radiative transfer models that can predict the impact that SAI may have.

Noise in IPN measurements comprises gas flow noise, ambient acoustic noise from sampling inlets and instrument walls, laser power noise, and sensor and electronic noise. Our IPNs currently use a single-pass, single-resonator configuration with three sensors (two photodiodes, one microphone) that measure the extinction and scattering of light and sound waves due to the photoacoustic effect from light absorption in the photoacoustic resonator. The primary source of measurement uncertainty is fluctuating laser power, which is influenced by ambient conditions and operational parameters that affect the laser's operating temperature and consequently its power output. The instrument has difficulty distinguishing real signals from laser fluctuations near the detection limit. This effect is present even in laboratory conditions and is exacerbated by highly dynamic ambient conditions during field measurements.

To mitigate these uncertainties in the single-resonator design, we have integrated an additional sensor to monitor the unattenuated laser power and correct the changing background signals due to laser power fluctuations in real-time. Additionally, we are investigating enhancements in sensitivity through computational acoustic and fluid dynamics simulations to analyze the effects of resonator geometry on acoustic amplification and flow noise, and the positioning of sampling inlets and outlets on acoustic noise. This study aims to refine the design of IPNs to improve measurements of aerosol scattering and absorption coefficients in the near-IR spectrum.

2IM.14

Near-UV (365 and 405 nm) CAPS PMssa Monitors for the In Situ Measurement of Particle Optical Properties.

ZACHARY PAYNE, Benjamin Moul, Stephen Jones, Andrew Freedman, Timothy Onasch, *Aerodyne Research, Inc.*

Heretofore, *in situ* measurement of the optical properties (e.g., extinction, scattering and absorption) of particulates has been limited to the visible region of the electromagnetic spectrum, typically in the 450 nm to 700 nm region defined by commercially available nephelometers. However, it has become increasingly clear that the effects on climate change by particles which absorb light below ~400 nm need to be quantitatively evaluated. We have been able to extend the range of in situ optical extinction and scattering measurements of Aerodyne's PM_{SSA} monitor to 405 and 365 nm, taking advantage of the development of powerful LEDs and highly reflective mirrors at these wavelengths.

The monitors utilize highly reflective mirrors (nominal transmission ~ 50 ppm) centered at 365 or 405 nm from FiveNines Optics and 365 nm LED ENGIN or 405 nm Luxeon light emitting diodes. The vacuum photodiode in a glass housing used in older instruments has been replaced by one from Hamamatsu which utilizes a metal can which appears to offer slightly higher sensitivity and is far more robust. As with CAPS PM_{SSA} monitors operating at longer wavelengths, these monitors demonstrates better than 1% linearity out to 1000 Mm^{-1} in both scattering and extinction channels. The level of detection (3σ, 1 second) in the extinction channel is less than 1 Mm^{-1} and below 3 Mm^{-1} in the scattering channel. (The latter value can readily be improved by using a higher count rate in the PMT used to measure the scattering signal.) The noise levels in both channels decreased as the square root of integration out to hundreds of seconds before baseline drift was observed. The measured truncation corrections in the scattering channel markedly increase as a function of wavelength (400 nm < <365 nm), presumably caused by the relatively poor reflectance of the integrating sphere below 400 nm.

2IM.15

Near-UV CAPS PMSSA Monitors for the In Situ Measurement of Particle Optical Properties. Zachary Payne, Benjamin Moul, Stephen Jones, Andrew Freedman, TIMOTHY ONASCH, *Aerodyne Research, Inc.*

Heretofore, in situ measurement of the optical properties (e.g., extinction, scattering and absorption) of particulates has been limited to the visible region of the electromagnetic spectrum, typically in the 450 nm to 700 nm region defined by commercially available nephelometers. However, it has become increasingly clear that the effects on climate change by particles which absorb light below ~400 nm need to be quantitatively evaluated. We have been able to extend the range of in situ optical extinction and scattering measurements of Aerodyne's PMSSA monitor to 405 and 365 nm, taking advantage of the development of powerful LEDs and highly reflective mirrors at these wavelengths.

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2IM.16

SMPS and DMA Calibration with Size-Certified Silver Aerosols from the Silver Particle Generator (SPG). Tobias Hammer, MOHSEN KAZEMIMANESH, Hans-Joachim Schulz, Konstantina Vasilatou, *National Physical Laboratory*

Scanning mobility particle sizers (SMPS), consisting of differential mobility analyzers (DMAs) and condensation particle counters (CPCs), should be regularly calibrated using size-certified particles in the sub-micrometer range. Previous study has shown that the silver particle generator (SPG, Catalytic Instruments) can generate silver particles with a mobility diameter down to ~5 nm in a stable manner. In this study, we characterize the commercially available SPG and evaluate its applicability for calibrations of DMAs and of entire SMPS systems. Different makes and models of SMPS / DMA were calibrated in the measurement campaign.

The arithmetic mean, geometric mean, and mode mobility diameters of the aerosols from two setpoints (setpoint 1 and 2 with a GMD_{mob} of 10 nm and 25 nm, respectively) were compared to the average geometric diameters determined by a size-traceable transmission electron microscope (TEM). The collected particles from both setpoints were analyzed for Feret diameter, projected area diameter, aspect ratio, and circularity using TEM image analysis. This comparison revealed a maximum offset between DMA and TEM of 0.8 ± 0.2 nm (i.e., ± 8% of nominal size) for the setpoint 1 when considering particle Feret diameter. The projected area diameter was slightly smaller and a greater offset of 1.2 ± 0.3 nm existed between DMA and TEM. For the setpoint 2, the maximum offset between DMA and TEM was 4.1 ± 0.5 nm off-set when considering Feret diameter, while this offset was larger when comparing to project area diameter of particles. The smaller offset observed for setpoint 1 is presumably due to nearly spherical particles produced in this setpoint (where their geometric and mobility diameters are similar), whereas we observed a mix of spherical and agglomerate particles in setpoint 2. These differences should be accounted for when calibrating SMPS and DMA.

2IM.18

An Aerosol Spectrometer Combination for Measurement across the Sub- and Super-Micrometer Regime.

JUSTIN HAMLIN, Raymond Leibensperger III, Jena Herbst, Meinrat O. Andreae, Kimberly Prather, *University of California, San Diego*

A range of aerosol spectrometers currently exists on the market and their capabilities have significantly increased since their widespread adoption in the 1970s and 1980s. The TSI Inc. Scanning Mobility Particle Sizer (SMPS) and Aerodynamic Particle Sizer (APS) are widely coupled in measurements across the sub- and super-micrometer aerosol regime. Advancements in instrumentation have yielded instruments with similar capabilities at a fraction of the cost, size, and weight with a slight trade-off in size resolution. Here, we compare the SMPS-APS with the Aerosol Dynamics Inc. Spider-MAGIC and TSI Inc. Optical Particle Sizer (OPS) combination, hereafter referred to as Spider-OPS, in the measurement of laboratory-generated and ambient aerosol. The SMPS-APS and Spider-OPS allow measurement of aerosol populations from 0.01 – 20 µm and 0.008 – 10 µm, respectively. The Spider-OPS boasts a small size (0.022 m^3) and weight (7 kg) with a total cost less than $70,000 which corresponds to 25% less in size and 21% less in weight for 37% less in cost compared to the SMPS-APS. The Spider-OPS show good agreement in their overlapping accumulation mode region and compare favorably to the SMPS-APS. Further, preliminary results measuring laboratory-generated sea spray aerosol (SSA) at the Scripps Ocean-Atmosphere Research Simulator (SOARS) wind-wave channel show good agreement between spectrometer combinations for particles with diameters within the Aitken (0.02 – 0.1 µm), accumulation (0.1 – 2.5 µm), and coarse modes (> 2.5 µm). These results emphasize that the smaller, more affordable aerosol spectrometer suite, Spider-OPS, is a valid alternative to the SMPS-APS for the measurement of aerosol size-resolved number distributions.

2IM.19

Improving PurpleAir PM2.5 Sensor Accuracy in Cold Conditions: Developing Tailored Correction Factors.

JENNO JOSEPH-LEENOSE-HELEN, Srijan Aggarwal, Raghu Betha, Dominique Pride, Alana Vilagi, *University of Alaska - Fairbanks*

Low-cost PM2.5 sensors have gained significance among air quality experts and citizen scientists due to the growing understanding of the harmful impacts of PM2.5 on human health. Renowned for their relatively high accuracy and affordability, PurpleAir (PA) sensors serve as reliable tools for measuring PM2.5 concentrations. Despite the development and application of various correction factors to enhance PA sensor accuracy, none adequately address the challenges posed by extreme cold conditions, particularly in interior Alaska. This study examines the efficacy of existing correction factors when applied to wintertime raw PA data from the city of North Pole, Alaska, revealing their inadequacy in low temperatures. Consequently, the research underscores the necessity for tailored correction factors specific to localized environments, especially at low temperatures. Upon identifying the shortcomings of existing models in low-temperature settings, we develop a new correction factor accounting for performance at low temperatures (0 to -25°C). The raw PA data is compared to PM2.5 concentrations reported by Beta attenuation monitoring (BAM) detectors to develop the correction factor. The study also revealed that PA sensors cease to function below -25°C and prolonged exposure to cold affects their performance, including the accuracy of any correction factors in predicting PM2.5 concentrations. Implementing a monthly correction factor may offer improved accuracy in correcting raw PA data. The proposed correction factor aims to empower residents of cold climates to utilize low-cost sensors for accurate measurement of localized PM2.5 concentrations, enabling informed decisions to mitigate exposure risks.

2IM.20

Evaluating Air Quality Using Low-Cost Sensor and Satellite Data at Schools in a Semi-rural US-Mexico Border Region Area of South Texas, USA.

KABIR BAHADUR SHAH, Sai Deepak Pinakana, Amit U. Raysoni, *The University of Texas Rio Grande Valley*

The Lower Rio Grande Valley (RGV) region of South Texas includes Hidalgo, Cameron, Willacy, and Starr counties, and is home to 1,399,446 people (Census Bureau 2022). This area is a majority-minority community with Hispanics/Latinos making up 91.8% of its population. The area has an employment rate at 50.88%, and median household income at $42,050. The inadequacy of air quality monitoring in the region is highlighted by the operation of just five Central Ambient Monitoring Sites (CAMS) overseen by the Texas Commission on Environmental Quality (TCEQ). Out of the five, only two of them measure O3 and four measure PM2.5.

As per the latest annual PM2.5 standards set at 9.0 µg/m3 by the USEPA's National Ambient Air Quality Standards (NAAQS) announced on February 7, 2024, two counties of the region i.e., Hidalgo and Cameron counties are officially deemed non-compliant with the PM2.5 standards (USEPA, 2024). As part of a project funded by the North American Development bank (NADB) and the United States Environmental Protection Agency (USEPA), PM of various sizes were measured at nine elementary schools in the semi-rural town of Roma, TX on the U.S.-Mexico border region, using TSI Blue Sky Sensors. The findings of the study also include NASA satellite data and its integration with ground-based sensors. The findings of this research endeavor add to the inadequate body of air quality literature for South Texas where traditionally there has been a dearth of such air quality studies.

2IM.21

Instrumentation Shortcomings in Asthma Studies: Implications for Accurate Particle Measurement and Health Outcomes.

DAVID WOOLSEY, Mohammadreza Khani, *AirSpeQ*

Understanding the behavior of aerosol particulates is crucial in asthma research, particularly the distinction between particles above and below 300nm, characterized by inertial versus diffusive behavior. In the lungs, sub-300nm particles, dominated by diffusion, tend to deposit on less wetted structures, potentially penetrating more directly into the bloodstream. Larger particles, dominated by inertia, settle on mucous-wetted surfaces, inhibiting direct penetration. This distinction may lead to different immune responses, a novel aspect to explore in asthma research.

We reviewed asthma-related particulate matter (PM) studies published over the past 15 years, evaluating them against stringent criteria to determine their efficacy in linking sub-300nm PM to asthma episodes. Criteria included detection competence, size spectrum coverage, equipment colocation, proximity to subjects, and real-time monitoring.

Our findings reveal that no existing study meets all these criteria, rendering them unable to definitively link sub-300nm PM to asthma episodes. For instance, Ketzel et al. (2003) studied particle distribution in various environments but did not colocate all equipment. Similarly, Wu and Boor (2021) and Sipilä et al. (2021) provided valuable insights but lacked continuous monitoring close to patients.

This gap highlights the need for well-designed studies to accurately assess the impact of sub-300nm particles on asthma. Addressing these shortcomings will enhance understanding and lead to more precise health outcome assessments.

Funding: This work was partially supported by NIH grant contributions, with acknowledgments to past support from NSF and NASA.

2NP.1

From Nucleation to Aerogels: The Evolution of Structure in CNT Aerosols Reactors and Methane Pyrolysis. ADAM M BOIES, Jack Peden, Shahzad Hussain, Mabel Qiao, Joe Stallard, Michael Glerum, Xiaoyu Qiu, *University of Cambridge*

Over the last two decades, the aerosol production of bulk carbon nanotube (CNT) materials has advanced from laboratory reactors to plants capable of 5 kt/year. The commercial interest in CNT production has led to new fundamental aerosol questions that are critical to the scale and ultimate viability of CNT production. The nucleation and growth of catalyst particles within pyrolytic reaction zones of a high temperature (~1200 °C) reactor ultimately dictate the density of CNT reaction and volume-time efficiency of the process.

This presentation will discuss our emerging understanding of the role of methane pyrolysis in the presence of iron-sulfur nanoparticles that serve as sinks for C2 species which are the feedstocks of CNT growth. A new class of aerosol CNT reactors are being developed that allow optical access to study the aerosol and pyrolytic reactions via in-situ methods, such as laser induced incandescence, infrared spectroscopy and multi-photon Raman techniques. Further, these reactors provide internal methods for heating, which eliminate the need for ceramic reactor walls, opening possibilities for bespoke design of reactor geometries and catalyst precursor injection strategies.

New catalyst synthesis techniques have been developed that enable control of the size distribution of catalysts. The use of unipolar charge enables suppression of particle-particle collisions, which reduces the polydispersity of the aerosol. The subsequent growth of a dense network of CNTs results in an aerogel formation, which has been studies by atomistic and hybridized models. The nucleation of the aerogel structure is achieved by prolongment of the reorientation timescales (analogous to spherical particle coalescence) that approach the collision timescales of the CNTs. The aerogelation dynamics are of interest to a broad range of new 1D materials that are envisioned to be produced by aerosol techniques.

2NP.2

Characterization of Plasma-Activated Fine Water Droplets Generated by Electrostatic Atomization Device. RYO SHIBUI, Tatsuo Ishijima, Tomoya Tamadate, Yohei Ishigami, Yusuke Kuromiya, Toshiaki Sakai, Hiroshi Suda, Takafumi Seto, *Kanazawa University*

Plasma-activated water is employed as an agent for inactivation of pathogens such as bacteria, viruses, and fungi due to its rich content of chemically active species e.g., hydroxyl radicals (OH) produced during plasma-liquid interactions at the liquid surface. The efficacy of these interactions is promoted by employing sprayed microdroplets by enlarging the surface area for plasma exposure, resulting in enrichment of the chemical activated concentration per droplet. In this study, we developed a novel device that produces finer droplets using an electrospray technique. We particularly investigated the influence of background gas conditions (N_2/O_2 ratio) on the droplet number concentration, droplet size distribution, and the generation rate of 2-hydroxyterephthalic acid (HTA) to estimate production of OH in droplets using a chemical probe method. Furthermore, we analyzed changes in the emission spectrum by spectroscopy of the plasma at the Taylor cone tip. The size distribution measurements revealed that ultra-fine particles are generated with minimal variation across all O_2 concentrations, with mode sizes ranging from 11.6 to 17.0 nm. Concurrently, droplet concentration measurements indicated a substantial decrease in concentration from 4.85×10^5 /cc at 0% O_2 to 57.4 /cc at 10% O_2, subsequently recovering to 4.63×10^3 /cc at 21% O_2. Beyond 21% O_2, no significant changes in droplet concentration were observed. Regarding HTA generation rate, it is increased with O_2 percentage from 1.54×10^{-13} mol/s at 0% to 9.88×10^{-12} mol/s at 100%. However, OH optical emission was not detected by plasma spectroscopy at all O_2 concentrations. Plasma spectroscopy also indicated that the purple emission at the Taylor cone tip results from the transition of N_2(C-B), with emission intensity decreasing as O_2 percentage increases. O optical emission was not detected at integration time of 1 s, with a slight emission at 10 s.

2PA.1

Advance Aerosol Separator for Planetary Exploration. PAUL CARPENTER, Dragan Nikolic, David Keicher, *Integrated Deposition Solutions Inc. (IDS)*

Integrated Deposition Solutions Inc. (IDS), the premier supplier of aerosol printing technology and manufacturer of the NanoJet line of aerosol printers, developed an aerosol separator (AS) for the Jet Propulsion Laboratory (JPL) for use with an aerosol mass spectrometer to investigate the chemistry of planetary atmospheres. IDS was awarded Phase 1 and Phase 2 SBIR grants to develop a robust particle separating apparatus that could survive launch from Earth, entry into the Venus atmosphere, and 12 months of continuous sampling of the atmosphere surrounding Venus. The AS is a key component between a throttling inlet valve, that is exposed to the planetary atmosphere, and a mass spectrometer’s vaporizer. The function of this device is to separate the atmospheric aerosol’s gas and liquid constituents, concentrate and collimate the extracted liquid into a narrow particle beam that can traverse several centimeters within a vacuum, and maintain a high transmission efficiency. IDS leveraged the technology within the NanoJet print head to develop a flow cell that focuses the incoming stream of highly corrosive aerosol into a particle beam approximately 2mm in diameter while removing the atmospheric gas. Test results have shown this particle beam is able to travel over 20cm, in a high vacuum, and impact a target in an adjacent vacuum chamber. The vacuum chamber adjacent to the AS on the testing setup acted as an analog to the mass spectrometer vaporizer chamber. While initially developed as a key instrumentation component for planetary atmospheric research, there are many potential commercial, industrial, regulatory, and other scientific applications for the IDS Aerosol Separator technology.

2PA.2

Synthesis of Diglycine in Single Suspended Micron-sized Aerosol Droplets. ALEXANDER LOGOZZO, Thomas Preston, *McGill University*

Elucidating synthetic routes for the formation of peptides under prebiotic conditions can provide us with fundamental knowledge about the origin of life. Aerosol particles in the atmosphere frequently exist in a supersaturated state, where the concentration can exceed that of the bulk solubility by an order of magnitude. Reaction rates can also be significantly enhanced in aerosol droplets and thermodynamically unfavorable reactions can be facilitated. Here, we investigate the potential for aerosol particles to act as efficient prebiotic reactors. By suspending aqueous droplets containing amino acids and dicyandiamide, we are able synthesize dipeptides in appreciable yields. We use a dual-beam optical trap to suspend single micron sized aerosol droplets and monitor their optical and chemical properties with cavity enhanced Raman spectroscopy. We show that the incident trapping laser is able to assist in the synthesis of the peptides. Additionally, the reaction rate is sensitive to the initial droplet radius indicating that the synthesis can be enhanced by scaling down the reaction vessel.

2PA.4

Early Earth Organic Haze as a Global Prebiotic Chemistry Source.

NATHAN REED, Karyn Rogers, Eleanor Browne, Margaret Tolbert, Boswell Wing, Shawn McGlynn, *Rensselaer Polytechnic Institute*

Atmospheric organic haze chemistry from methane photolysis has long been speculated to be a source of prebiotic molecules and nutrients in early Earth environments. However, the inclusion of sulfur, an essential element of biology, in prebiotic organic has chemistry has remained underexplored. Furthermore, in an early Earth environment, organic haze aerosol would settle out of the atmosphere onto the surface through deposition, most likely on bodies of water. Indeed, aqueous depositional processes would be a requirement for relevance to the prebiotic and early environmental fields. Yet, post-depositional chemical processes have been overlooked, and therefore the viability or potential role of organic haze in the context of prebiotic chemistry remains and open question. Here I present laboratory experiments that demonstrate that the inclusion of hydrogen sulfide (H2S) in haze chemistry yields a variety of key sulfur-bearing biomolecules as products. Further, I present results that directly couple atmospheric organic haze chemistry with aqueous and aqueous-mineral chemistry. The presented work focuses on prebiotic chemistry and nutrient relevance of organic haze products, adopting key ageing conditions, aqueous reactants, and minerals central to prebiotic chemistry studies. The results show the formation or destruction of any haze biomolecules over time using ultra-high-resolution orbitrap mass spectrometry. These results have important implications for understanding the synthesis, chemical processes, and fate of biomolecules produced from organic haze chemistry in the context of coupled early Earth environments.

2PA.6

Photochemical Production of Organic Haze from Inorganic Gases.

HANALEI LEWINE, Nathan Reed, Zachary Schiffman, Jeffrey Price, Margaret Tolbert, Eleanor Browne, *University of Colorado Boulder & CIRES*

Atmospheric hazes, the complex mixture of gases and aerosols produced by atmospheric chemistry and frequently initiated by photolysis, are common in planetary atmospheres, both in our solar system and on exoplanets. Photochemical hazes are important for climate and habitability. Organic aerosol (OA) is particularly important for prebiotic chemistry, as it is a potential abiotic source of complex organic molecules. Understanding atmospheric compositions that lead to OA is critical to elucidate how hazes impact radiative balance and for understanding how we interpret exoplanet spectra. Laboratory experiments are important for connecting atmospheric compositions to OA formation potential because the mechanisms for OA formation in exoplanetary atmospheres are unknown. Nitrogen/carbon dioxide (N2/CO2) atmospheres are of particular interest because of their connection to early Earth’s habitable, anoxic atmosphere. There is geochemical evidence of organic haze in the Archean atmosphere, formed via methane (CH4) photochemistry. Traditional thought is that CH4 is required for OA formation; however, recent work suggests that OA formation is possible in CO2-rich atmospheres in the absence of CH4 if water and/or hydrogen sulfide (H2S) are present. Here, we performed laboratory experiments of haze formation in Archean atmospheric analogs formed via far-UV irradiation of N2/CO2/H2S mixtures. We measured aerosol particles using aerosol mass spectrometry and gas-phase products using iodide chemical ionization mass spectrometry in real-time. We find that addition of trace H2S (5 ppmv) enables organic haze production in CO2-rich atmospheres without CH4. The aerosol was composed of OA and inorganic sulfate and the amount of OA exceeded that of a CH4/CO2 ratio of 0.5 (0.1% CH4/0.2% CO2) with no H2S. We hypothesize that formaldehyde and sulfuric acid are produced from CO2 and H2S photolysis, the latter of which catalyzes polymerization of the former, forming lower volatility organic species that condense to form OA.

2UA.1

New Particle Formation Events in Urban, Agricultural, and Arctic Environments. Haebum Lee, Hyungjin Cho, Young Jun Yoon, Joonwoo Kim, Bang Yong Lee, KIHONG PARK, *Gwangju Institute of Science and Technology*

Atmospheric nanoparticles with diameters ranging from a few to tens of nanometers can be produced by direct emission from various combustion sources and/or indirectly formed by gas-to-particle conversion process. The indirectly-formed particles were resulted from new particle formation (NPF) from precursor molecules through nucleation, condensation, and coagulation processes. The NPF has been frequently observed in various environments, significantly contributes to the number-based aerosol population in the ambient atmosphere. They usually grow to the larger particles, serve as cloud condensation nuclei (CCN) affecting climate change via cloud formation, and contribute to haze formation affecting human health. This study compares NPF characteristics among different atmospheric environments (urban, agricultural (livestock and cropland), and Arctic sites). The NPF occurrence frequency, occurrence criteria, particle formation rate (J), and growth rate (GR) obtained from continuous measurements of number size distribution of particles and various gases were compared to examine any differences in important factors to affect the NPF under different environments. At the livestock site in summer, much higher NH3 (79.6 ppb) and the estimated DMA (52.5 ppt) concentrations than those at other sites led to promote the NPF. At the Arctic, the high level of condensable vapors in addition to H2SO4 under strong photochemical and biological activity and the low level of pre-existing aerosols were maintained in summer, contributing to the higher occurrence of the NPF in summer than other seasons. The J varied more significantly than the GR among different sites, suggesting that the J should be more sensitive to different environments than the GR. Further results on NPF occurrence criteria and controlling factors to the criteria will be presented.

2UA.2

The Role of Oxidized Organic Compounds in Urban New Particle Formation. LEE TISZENKEL, James Flynn, Shanhu Lee, *The University of Alabama in Huntsville*

New particle formation (NPF) takes place frequently in polluted urban areas worldwide, impacting human health, air quality and climate. Past studies have proposed that urban NPF takes place via clustering of sulfuric acid with base species with a possible contribution by oxidized organic compounds. However, the exact mechanisms of urban NPF are poorly understood due to a lack of comprehensive measurements of NPF precursors at urban sites. We have made a comprehensive chemical analysis of NPF at a highly populated and polluted urban site in Houston, Texas. We measured gas-phase sulfuric acid, ammonia, amines, and oxidized organic compounds with three chemical ionization mass spectrometers (CIMS). Using the Filter Inlet for Gases and Aerosols (FIGAERO) we measured organic compounds both in the gas- and particle-phase, enabling the analysis of ambient gas-phase organic compounds as well as organic compounds that partition in to the particle phase. These measurements of gas-phase precursors and particle chemical composition were coupled with particle size distributions down to critical cluster diameters. We found that the presence of oxidized organic compounds is a critical criterion for NPF initiation in the urban atmosphere. Additionally, we found that the relatively lower ratio of organonitrates in Houston represents a distinct chemical environment that distinguishes the participation of organics in urban Houston NPF from other highly polluted areas such as Chinese megacities. Our observations for the first time give closure to both nucleation and growth rates with the measured sulfuric acid, base, and low-volatility highly oxygenated organic molecules. With rapidly growing urban heat islands and enhanced urban emissions, this multicomponent NPF process will play an increasingly more important role globally in the changing climate.

2UA.3

Exploring the Mechanisms of New Particle Formation in Houston with an Outdoor Chamber. JEREMY WAKEEN, Xuanlin Du, Samuel O'Donnell, Don Collins, Jeffrey R. Pierce, James Smith, *University of California, Irvine*

New particle formation (NPF) has been shown to occur in urban areas with high pre-existing particle concentrations, but the mechanisms of nucleation and growth are poorly understood. NPF events have been observed previously in Houston, TX, however no direct measurements of the composition of newly formed particles or gaseous precursors have been performed. During July and August 2022, the TRacking Aerosol Convection interactions ExpeRiment (TRACER) in Houston, we deployed a suite of instruments to measure highly oxidized molecules (HOMs) and 10-100 nm diameter nanoparticles formed in the Captive Aerosol and Growth Evolution (CAGE) chamber that removes ambient pre-existing particles so that only ambient gases undergo photooxidation and gas-particle conversion. Particles formed in CAGE can be compared to those in ambient air, providing insights into the importance of local and regional emission sources and transport processes. We measured nanoparticle composition formed in CAGE using Thermal Desorption Chemical Ionization Mass Spectrometry (TDCIMS) and gas-phase HOMs using nitrate-CIMS. Measurements are supplemented by process-level modeling of gas-phase oxidation chemistry, including HOM formation and aerosol microphysics such as nucleation, coagulation, condensation, and evaporation. NPF was observed nearly every day, sometimes multiple times in a day, in CAGE during the observation period. TDCIMS measurements indicate sulfate, multifunctional organosulfates, amines, ammonium, and other highly functionalized organics dominate the composition of these newly formed particles. The model successfully reproduces the timing of these events and predicts an important role for both sulfuric acid as well as oxidation products of aromatics in these events.

2UA.4

Investigating Contributors to Nanoparticle Growth Using an Ambient Air-Tracking Chamber. XUANLIN DU, Jeremy Wakeen, Samuel O'Donnell, Jeffrey R. Pierce, James Smith, Don Collins, *University of California, Riverside*

New particle formation (NPF) and subsequent growth of atmospheric aerosols play a critical role in generating cloud condensation nuclei (CCN), which significantly impact cloud properties and climate. However, there are still large uncertainties in the mechanisms and rates of NPF and particle growth. Previous measurements in Houston’s urban setting observed NPF events but did not include a comprehensive analysis of the factors that may contribute to the NPF frequency and growth rates.

This work presents data from the TRACER-Ultrafine aerosol Formation and Impacts (TRACER-UFI) campaign, conducted in Houston, TX during July and August 2022. We utilized a 2-cubic meter portable chamber, operating with entirely or mostly ambient gases under natural light conditions. We observed daily NPF events inside the chamber, with multiple events occurring on many days. The growth of newly formed particles was tracked using a scanning mobility particle sizer and their composition was measured with a thermal desorption chemical ionization mass spectrometer. We investigated the influence of meteorological factors, ambient gas-phase pollutant concentrations, and aerosol chemistry on particle growth rate in the chamber. Notably, our analysis revealed distinct correlations between growth rate and meteorological variables during July and August, possibly due to variations in the dominant chemical compounds contributing to growth across these two months. Furthermore, we observed a negative correlation between growth rate and particle volatility.

2UA.5

Anthropogenic Monoterpenes and Monoterpenoids as Important Precursors for Secondary Organic Aerosol in US Cities. MASOUD AKBARZADEH, Huiying Luo, Abraham Dearden, Alison Piasecki, Ann M. Middlebrook, Lauren A. Garofalo, Delphine K. Farmer, Matthew Coggon, Cort Zang, Karl Seltzer, Benjamin Murphy, Havala Pye, Katelyn Rediger, Carsten Warneke, Damien Ketcherside, Lu Hu, Tucker Melles, Audrey Lawrence, Megan Willis, Shantanu Jathar, *Colorado State University*

Volatile chemical products (VCP) are likely to be important sources of secondary organic aerosol (SOA) precursors in urban environments. The use of personal care and cleaning products results in anthropogenic emissions of reactive organic compounds like terpenes (i.e., monoterpenes and monoterpenoids) that can be oxidized to form SOA. In this work, we combined environmental chamber data, kinetic models, and chemical transport models to study how terpenes may contribute to the anthropogenic SOA burden in cities in the United States. We analyzed chamber data on a multitude of terpenes (e.g., alpha-pinene, limonene, alpha-terpineol, and linalool), as well as mixtures like pine oil, to quantify their SOA mass yields. These data were used alongside a kinetic, process-level model (SOM-TOMAS) to develop volatility basis set parameters for a regional chemical transport model (CMAQ). Ongoing work is focused on the development and application of CMAQ to predict precursor-resolved estimates for SOA over several large cities in the US (e.g., Los Angeles, Chicago, New York City). We will compare the magnitude and patterns of terpene-originated SOA to those from transportation, industrial, and oil and gas activities, to understand the contribution of terpenes to urban air quality.

2UA.6

Investigating Thermal-stress Response in Common Landscaping Plant to Elucidate Changes in Urban Forest BVOC Emissions as a Result of Climate Change. JASMINE OSEI-ENIN, Juan Flores, Celia Faiola, *University of California, Irvine*

Urban forests can serve as a source of volatile organic compounds (VOCs) that contribute to secondary organic aerosol (SOA) and ozone production. VOC emissions from urban plants are likely to increase during extreme heat events that are becoming more severe and frequent as a result of the compounding effect of climate change, high urbanization rates, and heat island effects. Currently, plant VOC literature, including plant stress VOC research, is dominated by coniferous and deciduous trees because they are the largest source of biogenic VOCs (BVOCs) globally. However, it is important to characterize urban BVOC emission profiles to improve understanding of urban air quality and potential human health impacts. To address this knowledge gap, this study quantified BVOC emissions from healthy and thermally-stressed plants, focusing on a species that is commonly used for landscaping in Southern California, *alpinia zerumbet*. We observed physiological stress response in photosystem II efficiency, and changes in VOC composition and emission in response to heat treatment. These emission changes were normalized to modeled emissions to track deviation from the expected. Evaluating the BVOC profile of urban forests is critical to effectively respond to and mitigate public health impacts of increased particulate matter and ground-level ozone as a direct result of climate change-induced heat stress within the urban environment.

2UA.7

Analysis of Particulate Matter Fraction in an Urban Area, Brazil.

RAFAELA SQUIZZATO, Thiago Nogueira, Caroline Fernanda Hei Wikuats, Maria de Fatima Andrade, Edmilson Dias de Freitas, *University of São Paulo*

Utilizing sustainable fuel alternatives is crucial for reducing atmospheric emissions, especially in major cities where vehicular traffic is the primary source of pollution. Even cities that have good urban planning, like Curitiba in the state of Paraná, air pollution can still be a challenge. The present study focuses on analyzing diurnal, seasonal, and weekly patterns of $PM_{2.5}$ and PM_{10} in Curitiba's central area. The station, currently managed by the Water and Land Institute, is situated in Ouvidor Pardinho square, which has moderate traffic, mainly from cars, with the surrounding area characterized by low buildings and some trees. Hourly data from 2023 was analyzed using the Openair package provided by the R software. The analyzes revealed that the concentrations of $PM_{2.5}$ (mean: 9.7 ± 8.6 $\mu g\ m^{-3}$) and PM_{10} (mean: 20.5 ± 17 $\mu g\ m^{-3}$) exceeded the new guideline values set by the World Health Organization (WHO), mainly in winter. During the winter months (June, July, and August), the highest concentrations of $PM_{2.5}$ and PM_{10} were observed with South winds. In autumn (March, April and May), the highest concentrations occurred from North/Northwest and East directions, for both fractions. In terms of diurnal behavior, particulate matter concentrations peaked above 10 $\mu g\ m^{-3}$ ($PM_{2.5}$) and 20 $\mu g\ m^{-3}$ (PM_{10}) in the early morning (6 a.m) and late afternoon (6 p.m), directly related to the circulation of vehicles in the area. Additionally, on weekends, a smoothing out of concentration peaks during rush hour can be observed. Despite having a significant local impact, particulate matter concentrations can be influenced by sources from further away. However, to better understand this behavior, a more comprehensive study involving chemical composition analysis on filters is needed to assist in identifying sources.

2UA.8

Impact of Urban Form on pm2.5 Concentration in Indian Metropolitan Cities.

HIMANK SEN, Lovleen Gupta, *Delhi Technological University*

Urban form planning has become an essential strategy to reduce air pollution and improve air quality in urban areas. Fine particulate matter (PM2.5) is the main pollutant, which poses significant health risk and environmental challenge. Understanding the relationship between PM2.5 and urban form is crucial for designing effective mitigation strategies in current scenario where population is increasing exponentially and urban migration is also increasing. This study explores the relationship between urban form metrics like LSI (Landscape Shape Index), Division (Landscape Division Index), COHESION (Patch Cohesion Index), PARA_MN (Mean Perimeter Area Ratio), etc., as determined by analysing Land Use-Land Cover data in FRAGSTAT and PM2.5 concentration retrieved for Indian metropolitan cities from 2000 to 2020. We explored the spatial distribution of PM2.5 concentrations and assessed the correlation with different urban form metrics. Six control variables, including temperature, NDVI, precipitation, wind speed, population and GDP per capita were selected for use in multiple linear regression models.

In the study preliminary findings suggest that PM2.5 concentrations exhibit spatial variability across Indian metropolitan cities, influenced by diverse urban form factors. Higher PM2.5 levels were observed in areas with denser urban development, more fragmentation, and limited green spaces. Conversely, areas with compact land use patterns and better connectivity tend to have lower PM2.5 concentrations.

The findings of this study provide valuable insights for policymakers, urban planners, and stakeholders involved in mitigating air pollution and promoting sustainable urban development. By integrating urban form considerations into air quality management strategies, cities can work towards creating healthier and liveable urban environments for their residents.

Keywords: PM2.5, Landscape shape index, Landscape division index, patch cohesion index, fragstats, NDVI.

2UA.9

Quantifying HAPs from Tier II and Tier III OGVs. KYAH GRACIA, *University of California, Riverside*

This body of work proposes the study of the community impacts from hazardous air pollutants (HAPs) from various sources. Composed of several studies, the first being real-time composition of tier II marine vessel emissions and comparing the efficiency to tier III OGVs. Both vessels have been built by the same shipbuilder and engine manufacturer. This study will serve to quantify the chemical composition and concentration of HAPs from marine vessels between the two technology classes and regulatory fuel blends. A full spectrum of samples has been taken from the main engines at various speeds with respect to the regulated engine load points based off of the ISO 8178 testing cycle. Samples will be collected with the two regulated fuels used in operation. Work shown will be gathered from two tier III vessels, and one tier II vessel. All three engines being classified as category 3. Full speciation analysis will show the OC:EC ratio, as well as present HAPs from the stack emissions.

2UA.10

Modeling the BC and PM2.5 Emissions Changes and Exposure Impacts of Medium- and Heavy-Duty Truck Modernization and Decarbonization. JAMES D.A. BUTLER, Chelsea V. Preble, Fona Ou, Wanshi Hong, Bin Wang, Alan Jenn, Thomas W. Kirchstetter, Ling Jin, *University of California, Berkeley*

People who live near magnet sources (e.g., ports, warehouses) and goods movement corridors are exposed to black carbon (BC) and fine particulate matter ($PM_{2.5}$) from diesel medium- and heavy-duty vehicles. In California, like in most of the United States, there are race and class disparities in air pollution exposure from goods movement. To reduce traffic air pollution, state and federal governments have established emission limits for diesel engines. In California, the 2007 Drayage Truck Rule and 2010 Truck and Bus Regulation set requirements that accelerated the use of diesel particle filters and selective catalytic reduction systems in the on-road truck fleet. The next stage of truck fleet regulation begins in 2025 with the Advanced Clean Fleet Rule (ACFR), which mandates a transition to zero-emissions vehicles like battery electric trucks.

We model changes in annual $PM_{2.5}$ concentrations due to these regulatory programs across California with 1 km grid resolution in densely-populated regions with the Intervention Model for Air Pollution (InMAP) source-receptor matrix for 2000–2050. Truck activity on major roadways and electric truck charging events are obtained from the Berkeley Lab Medium- and Heavy-Duty Electric Vehicle Infrastructure – Load Operations and Deployment Modeling Tool (HEVI–LOAD). We leverage in-use emission factors (EFs) captured during measurement campaigns throughout implementation of fleet regulations (Preble et al., ES&T 2015; 2018; 2019) supplemented with the California Air Resources Board (CARB) EF database (EMFAC). Marginal emissions from electric truck charging demand are simulated in the UC Davis Grid Optimized Operation Dispatch (GOOD) model. Population-weighted average concentrations by race and class are calculated at a census block level. Preliminary results for the ACFR where electric trucks grow from 2% to 70% of the fleet over 2024–2050, along with 100% electric drayage trucks adoption by 2035, demonstrate an annual PM2.5 concentration reduction of ~1 [$\mu g/m^3$].

2UA.11

A Decade of On-Road Heavy-Duty Diesel Truck Emission Control Performance Characterization during California's Fleet Modernization. CHELSEA V. PREBLE, Robert Harley, Thomas W. Kirchstetter, *University of California, Berkeley*

Diesel particle filter (DPF) and selective catalytic reduction (SCR) emission controls are standard on new heavy-duty diesel trucks (HDDTs) to reduce particulate matter and nitrogen oxides (NO_x = NO + NO_2). California's Truck and Bus Regulation accelerated fleet turnover and adoption of these technologies, such that all HDDTs in the state must now be equipped with 2010 and newer engines that are DPF- and SCR-equipped. To evaluate these controls under real-world conditions over time, tailpipe exhaust emissions from thousands of in-use trucks were measured at the Caldecott Tunnel near San Francisco (2014, 2015, 2018, 2021, 2022, 2023). Emission factors (g kg^{-1}) of black carbon (BC), NO_x, NO_2, nitrous oxide (N_2O), and ammonia (NH_3) were calculated on a truck-by-truck basis using a plume-capture, carbon-balance approach. Emission profiles for each truck were linked to engine model year and emission controls by matching license plates to state-managed databases.

DPF-equipped trucks increased from 15% in 2010 (pre-regulation) to >99% of the fleet in 2022, and SCR use increased from 2% to 91%. Fleet-average BC and NO_x emission factors over that same period decreased by ~80%. The majority of BC emissions by 2007–2009 engines and NO_x emissions by pre-2013 engines measured in 2022 were higher than relevant emission standards. Notable increases in BC from 2007–2009 engines indicate reduced DPF performance with aging, which may be due to frequent active regeneration. Emissions distributions are increasingly skewed, with the highest emitting 10% of the 2022 fleet responsible for 66% of NO_x and 91% of BC. The top 10% of emitters do not necessarily overlap between pollutants, however. Removing the top 10% of NO_x emitters would have the largest co-benefit by reducing fleet emissions of BC (30%), N_2O (25%), and NH_3 (18%). These results may reflect changes occurring elsewhere and are important for emission inventory and policy development.

2UA.12

Primary and Secondary Emissions from a Modern Fleet of City Buses. LIYUAN ZHOU, Qianyun Liu, Christian M. Salvador, Michael Le Breton, Mattias Hallquist, Jian Zhen Yu, Chak K. Chan, Åsa M. Hallquist, *King Abdullah University of Science and Technology*

The potential impact of transitioning from conventional fossil fuel to a non-fossil fuel vehicle fleet was investigated by measuring primary emissions via extractive sampling of bus plumes and assessing secondary mass formation using a Gothenburg Potential Aerosol Mass (Go:PAM) reactor from 76 in-use transit buses. Online chemical characterization of gaseous and particle emissions from these buses was conducted using a chemical ionization mass spectrometry (CIMS) with acetate as the reagent ion, coupled with a filter inlet for gases and aerosols (FIGAERO). A significant reduction (48-98%) in fresh particle emissions was observed in buses utilizing compressed natural gas (CNG), biodiesels like rapeseed methyl ester (RME) and hydrotreated vegetable oil (HVO), as well as hybrid-electric HVO (HVO_{HEV}), compared to diesel (DSL) buses. However, secondary particle formation from photooxidation of emissions was substantial across all fuel types. The median ratio of particle mass emission factors of aged to fresh emissions increased in the following order: DSL buses at 4.0, HVO buses at 6.7, HVO_{HEV} buses at 10.5, RME buses at 10.8, and CNG buses at 84. Of the compounds that can be identified by CIMS, fresh gaseous emissions from all Euro V/EEV buses, regardless of fuel type, were dominated by nitrogen-containing compounds such as nitrous acid (HONO), nitric acid (HNO_3), and isocyanic acid (HNCO), alongside small monoacids (C_1-C_3). Notably, nitrogen-containing compounds were significantly reduced in Euro VI buses equipped with more advanced emission control technologies. Secondary gaseous organic acids correlated strongly with gaseous HNO_3 signals (R^2= 0.85-0.99) in Go:PAM, but their moderate to weak correlations with post-photooxidation secondary particle mass suggest they are not reliable tracers for secondary organic aerosol formation from bus exhaust. Our study highlights that non-regulated compounds and secondary pollutant formation, not currently addressed in legislation, are crucial considerations in the evaluation of environmental impacts of future fuel and engine technology shifts.

2UA.13

Mapping the Spatial Distribution of 2.5 to 10 nm and Total Particle Concentrations on Highways, Secondary, and Tertiary Roads. JONAH HAZELWOOD, Lintong Cai, Stephanie Bachman, Nicholas Meskhidze, Markus Petters, *North Carolina State University*

Ultrafine particles (UFPs), defined as particles with a diameter < 10 nm, are an area of growing interest due to their implications for air quality and human health. Previous studies suggested that vehicular emissions (particularly from diesel-fueled vehicles) are responsible for most emissions in urban environments. Exposure to UFPs is known to cause a variety of cardiovascular, respiratory, and neurological disorders. The airborne UFP dynamics involves particle emissions, dispersions, chemical and physical transformations in the atmosphere, and variabilities in local meteorological parameters. Here we show measurements from a mobile platform designed to map the spatial distribution of particles between 2.5 and 10 nm in diameter. The system deployed in Raleigh, NC consisted of 3 condensation particle counters (CPCs), a nano SMPS, a high-resolution GPS, a sonic anemometer, and a mobile power station. Traffic was observed using a dashboard camera. A composite map detailing gridded, averaged data from all sampling days was produced alongside a traffic volume map, illustrating a correlation between 2.5 to 10 nm particle concentrations and traffic flow in the city. It was found that tertiary roads (low-traffic residential areas) were relatively clean, with particle concentration < 2000 cm-3. Particle concentrations exceeding 700,000 cm-3 were observed intermittently on secondary roads and highways and attributed to a few super-emitter vehicles. Super-emitters (such as diesel trucks and scooters/motorcycles) were identified by geolocating the aerosol concentration data with traffic images. We found a high spatiotemporal variability of UFPs. Both 2.5 to 10 nm and total particle concentration varied by more than an order of magnitude within several seconds. Concentration dropped to background levels on roads 120 m from the highway. This talk will highlight the usefulness and limitations of mobile aerosol measurements for determining the emission of ultrafine particles from non-stationary sources.

2UA.14

Secondary Organic Aerosol Formation from Tire Emissions in an Oxidation Flow Reactor. MINGHAO HAN, Don Collins, *University of California, Riverside*

Partly as a consequence of the significant reductions in vehicular exhaust emissions over the past few decades, non-exhaust emissions, such as those from brake and tire wear, are now recognized as an increasingly significant source of traffic-related particulate pollution. Previous tire wear research has predominantly focused on the emissions of primary aerosol particles, while the study of gaseous organic compounds emitted directly from tires remains substantially underdeveloped. The composition of these gaseous emissions can be complex due to the variety of additives used in tire production to meet different performance standards, leading to variability in emissions based on different manufacturing and processing techniques. Moreover, the detailed mechanisms through which these chemical compounds transform in the atmosphere, and the environmental fate of these emissions are not well-understood. Our study specifically examines the potential SOA formation from tire emissions using an oxidation flow reactor (OFR). We conducted experiments employing a custom-built enclosure in which whole tires were heated to temperatures expected while in use. Tires of various brands, types, and ages were tested to evaluate the SOA formation potential of emitted precursors. Findings from the study enhance our understanding of the complex processes by which tire emissions contribute to urban air pollution.

2UA.15

Diel Formation and Oxidative Aging of Secondary Organic Aerosol Generated from Phenol Using a Combined Smog Chamber and Oxidation Flow Reactor Approach. DAVID PANDO, Bin Bai, Chase Glenn, Andrew Lambe, Pengfei Liu, Nga Lee Ng, *Georgia Institute of Technology*

Secondary organic aerosols (SOA) have long been an integral component of air pollution studies and have been widely characterized in different laboratory settings. After the initial formation, the SOA aging process involves a series of chemical and physical transformations that can significantly alter their composition, size, and properties. However, resulting complexities from the formation of multi-generation products and their continued aging are not well elucidated, and most laboratory SOA studies to date have restricted their focus to hydroxyl (OH) or nitrate (NO_3) radical-initiated aging without considering the effects of diel aging that occurs in the atmosphere. In this work, a novel setup combining an integrated Georgia Tech Environmental Chamber (GTEC) and oxidation flow reactor (OFR) is used to investigate the influence of diel aging on SOA generated from OH or NO_3 oxidation of phenol in the GTEC followed by NO_3 or OH oxidation of phenol and its oxidation products in the OFR. This combination setup allows for the characterization of multi-generation gas-phase products and SOA composition as a function of aging time and mechanism. Phenol and its oxidation products are monitored by a suite of on-line instruments such as gas chromatograph with a flame ionization detector (GC-FID), scanning mobility particle sizer (SMPS), Filter Inlet for Gases and Aerosols coupled to a chemical ionization mass spectrometer (FIGAERO-CIMS), Vocus proton transfer-reaction mass spectrometer, and aerosol mass spectrometer (AMS).

2UA.16

Direct Observation of Wintertime Secondary Formation of Sulfate in Ambient Aerosols in Fairbanks, Alaska. JINGQIU MAO, Kunal Bali, James Campbell, Ellis Robinson, Peter F. DeCarlo, Amna Ljaz, Brice Temime-Roussel, Barbara D'Anna, William Simpson, Athanasios Nenes, Rodney J. Weber, *University of Alaska Fairbanks*

Sulfate comprises an average of 20% of the ambient PM2.5 mass during the winter months in Fairbanks, based on 24-hour average filter measurements. During the ALPACA 2022 field campaign (Jan 15th-Feb28th of 2022), we deployed two aerosol mass spectrometers (AMS) and one aerosol chemical speciation monitor (ACSM) at three urban sites, combined with Scanning Mobility Particle Sizers (SMPSs), to examine the evolution of aerosol composition and size distribution at a sub-hourly time scale. During an intense pollution episode (ambient temperature is between -25 and -35 °C), all three instruments (two AMS and one ACSM) exhibit a sharp increase in sulfate mass within a matter of hours, contributing to approximately half of the observed change in ambient PM2.5 mass concentration. The abrupt rise in sulfate mass concentration is concurrent with a substantial increase in particle size, growing from small particles ($D_p < 100$ nm) into larger particles ($D_p > 100$ nm). This increase in size suggests the secondary formation of sulfate onto pre-existing aerosols. We further investigate possible mechanisms and have ruled out the roles of cloud chemistry and transition metal ion conversion of SO2 to sulfate in PM2.5. The rapid formation of sulfate appears to coincide with the spikes of ambient nitrogen oxides concentration. Further investigation is underway to elucidate the intricate connections underlying this rapid sulfate formation.

2UA.17

Impact of Fixed Sources on Urban Aerosol Formation in Sao Paulo State, Brazil. IARA DA SILVA, Caroline Fernanda Hei Wikuats, Tailine Corrêa dos Santos, Leila Droprinchinski Martins, Edmilson Dias de Freitas, *University of São Paulo*

Aerosols are airborne particles that range in size from nanometers to micrometers. In major urban areas, aerosols from anthropogenic sources are associated with several human health problems. On both regional and global levels, the health impacts are highlighted, but aerosols also significantly influence Earth's radiative balance and climate through direct and indirect mechanisms. Therefore, it is crucial to understand the formation, spatial and temporal evolution, and chemical composition of aerosols. The state of São Paulo faces air quality issues related to aerosols. According to the Environmental Company of the State of São Paulo (CETESB), fine particles with diameters smaller than 2.5 micrometers frequently exceed legal state limits. Studies indicate that vehicle emissions are the primary source of atmospheric aerosols in São Paulo, while approximately 40% originate from fixed and other sources . To investigate the impact of fixed sources on particle concentrations in the São Paulo region, simulations were conducted using the WRF-Chem model. In the northern part of the São Paulo state, significant fixed sources are related to energy production from the combustion of sugarcane bagasse, as it is an important sugar-alcohol hub in the country. Additionally, the city of Paulínia, near the metropolitan region of São Paulo, hosts a cluster of ceramic industries, which are high emitters of aerosols. Meanwhile,Cubatão, located on the coast, has historically been significantly impacted by industrial emissions. Our study shows that industrial emissions impact particle concentrations, with values around 20 µg/m³ in the state. During the simulated period, 10 to 25th June, 2019, industrial emissions accounted for approximately 48% of the PM2.5 concentration at stations located in the Cubatão region. This result aligns with other studies indicating that industrial processes are a major source of PM2.5 in the Cubatão region.

2UA.18

Two-stage Secondary Organic Aerosol Formation in Low-temperature Combustion. ANITA ANOSIKE, Omar El Hajj, Chase Glenn, Samuel Hartness, Annabelle W. Hill, Nicholas Dewey, Daelyn Moore, Heeseung Choi, Jonathan Amster, Brandon Rotavera, Rawad Saleh, *University of Georgia*

We have previously demonstrated that n-alkanes that exhibit two-stage ignition also exhibit two-stage primary organic aerosol (POA) formation. The second-stage POA forms at temperatures larger than 1000 K via the soot-formation route, while the first-stage POA forms at 500 K – 700 K via alkylperoxy radical chemistry that involves sequential oxidation reactions of cyclic ethers. Here, we investigate secondary organic aerosol (SOA) formation during first-stage and second-stage ignition of n-pentane.

We conducted combustion experiments in a steady-flow reactor at fuel-rich (equivalence ratio = 2) and dilute ($O2 / N2 = 0.1$) conditions, at temperatures between 500 K – 1300 K to capture first-stage and second-stage ignition. To generate SOA through oxidation with OH radicals in an oxidation flow reactor (OFR), the emissions were first passed through a filter to remove POA particles and isolate the gaseous emissions.

SOA exhibited temperature-dependent two-stage formation, consistent with n-pentane two-stage ignition behavior. The peak second-stage SOA mass concentration (1250 K) was a factor of two larger than POA mass concentration at the same temperature, while the peak first-stage SOA concentration (700 K) was two orders of magnitude larger than the peak first-stage POA concentration (600 K). These results are consistent with previous reports of significantly higher levels of SOA compared to POA in emissions of gasoline engines.

Gas-phase measurements revealed that the second-stage SOA precursors were predominantly aromatic species (benzene and toluene), which are typically associated with anthropogenic emissions. While, the first-stage SOA precursors featured n-pentane first-stage ignition intermediates, including cyclic ethers, which have not been previously associated with anthropogenic emissions.

This study provides evidence that SOA precursors are emitted at high levels during low-temperature combustion, which is encountered during cold-start conditions. With most urban driving occurring at cold engine conditions, our results highlight the importance of low-temperature combustion emissions as SOA precursors in urban atmospheres.

2UA.19

Associating Traffic Related Aerosol in the Near-Road Environment to Urban Characteristics. RICARDO MORALES BETANCOURT, Daniela Mendez, Diego Roberto Rojas-Neisa, Luis Angel Guzman, *Universidad de los Andes*

Traffic related air pollution (TRAP) is a dominant source of exposure to particulate matter in urban areas. Due to the rapid introduction of low- and zero-exhaust emission vehicles around the world, the aerosol particles in the near-road environment are evolving rapidly. Understanding how different factors such as road geometry, traffic volume and vehicle technology, urban-background concentrations, and urban tree cover affect exposure to traffic related air pollutants in the near road environment is key to implement effective interventions to reduce such exposure. The city of Bogotá, in Colombia, which still faces serious air pollution levels, has recently adopted cleaner public policies aiming at improving air quality. Among these, the city is planning to transform one of the main roads in the city by increasing public space for pedestrians and cyclists, allowing only fully electric public transport buses along the road, and decreasing the number of mixed-traffic lanes. In this work, we report on the characterization of the near-road aerosol particles in a 22 km stretch of this main road with the purpose of understanding, through measurements, the most relevant factors determining exposure to TRAP. Our measurements determined the aerosol size distribution and particle number concentration (from 10 nm to 10 µm), as well as black carbon, PM2.5 and CO2. The measurements were carried out in 9 bus-stops, as well as personal exposure measurements for pedestrians and cyclists collected over hundreds of km traveled along the main road. During the sampling period, we recorded traffic counts every 5 minutes. Categories for motorcycles, light-duty vehicles, SUVs, and different types of public transport buses (either CNG, fully electric, or diesel-powered) were also recorded. The geometry of the road was carefully determined to establish an "urban canyon" index. The results of this observational study demonstrated high concentrations of black carbon (19.1 µg/m^3) and ultra fine particles (55,000 #/cm^3) throughout the campaign. For the analysis, the concentration time-series were decomposed in a slow- and a rapid-varying component. We found a strong association between the fast-varying aerosol field and traffic volume, while the slow-varying part was closely associated with background concentrations and street geometry. Furthermore, our data suggests that the frequency of high BC concentration events can be explained by the frequency of heavy-duty diesel vehicles. These events, however, only explain a minor fraction of the observed BC concentration, suggesting that motorcycles and light-duty vehicles are significant sources of BC and UFP in this road.

3AC.1

A Comparative Study on the Evaporation Kinetics and Physical Properties of Acyclic and Cyclic Terpene SOA. SIJIA LIU, Claire E. Moffett, Gregory W. Vandergrift, Zezhen Cheng, Swarup China, Sergey Nizkorodov, Alla Zelenyuk, Celia Faiola, *University of California, Irvine*

This study aims to compare physical properties and chemical composition of secondary organic aerosols (SOA) prepared from acyclic and cyclic terpenes. Plant stress commonly enhances the release of acyclic terpenes, yet the aerosol chemistry and properties of these compounds remains poorly understood, introducing uncertainties into global climate impact assessments of SOA. We generated SOA through the OH oxidation of acyclic and cyclic monoterpenes (β-ocimene, α-pinene) and sesquiterpenes (β-farnesene, β-caryophyllene) in a batch mode chamber. The single particle density, morphology, evaporation kinetics, and mass spectra were examined using single particle mass spectrometer (miniSPLAT), while molecular level SOA composition was analyzed via nanospray desorption electrospray ionization high-resolution mass spectrometry (nanoDESI-HRMS). The room-temperature evaporation kinetics of size-selected particles was examined by monitoring the changes in particle size and shape for up to 24 h, offering information about the volatility and viscosity of SOA particles. Our findings indicate that SOA from acyclic terpene OH oxidation exhibits higher viscosity and lower volatility compared to their cyclic counterparts. Sesquiterpene-derived SOA generally shows greater viscosity and reduced volatility, attributed to the high molar mass and low vapor pressure of their precursors. We find β-ocimene SOA displayed viscosity and volatility profiles similar to those of β-caryophyllene SOA. The efficiency of producing SOA from acyclic terpenes underscores the need to account for plant stress responses and subsequent acyclic terpene aerosol chemistry in climate and air quality models.

3AC.2

The Influence of Internal Mixing of Organic Acids and Sea Salt on Size-Resolved Aerosol Refractive Index and Hygroscopicity. MIGUEL HILARIO, Eva-Lou Edwards, Cassidy Soloff, Kayla Preisler, Armin Sorooshian, *University of Arizona*

Internal mixing of sea salt with organic acids impacts ambient aerosol optical and hygroscopic properties, which has implications for radiative effects, cloud droplet formation, and remote sensing. In this study, we used the Differential Aerosol Sizing and Hygroscopicity Spectrometer Probe (DASH-SP) to understand the influence of five organic acids (oxalic, malonic, succinic, glutaric, adipic) and methanesulfonic acid on the hygroscopic growth factor (GF) and the real part of the refractive index of sea salt. The analysis was performed on binary mixtures of NaCl and each acid for six dry particle sizes (200 – 1000 nm), a wide range of subsaturated relative humidities (20 – 95%), and five molar ratios (NaCl only, 2:3, 1:1, 3:2, acid only). The resulting GFs were greatly influenced by the particle dry size, with larger particles exhibiting higher GFs. Mixture properties such as the specific species mixed with NaCl and their molar ratio resulted in notable differences in the extent of particle growth upon deliquescence but did not significantly affect the relative humidity at which deliquescence occurred. This presentation will also discuss results of size-resolved real refractive index measurements in relation to composition. Understanding the impact of internal mixing on ambient aerosol hygroscopic and optical properties is critical for climate-sensitive regions such as the Arctic, which experiences periodic smoke transport rich in organic aerosol that can mix with the Arctic’s naturally abundant sea salt. These results also inform future sampling campaigns involving the DASH-SP such as the NASA Arctic Radiation-Cloud-Surface-Aerosol-Interaction Experiment (ARCSIX) occurring during May – August 2024.

3AC.3

Seasonal Dependence of Particle Number and Mass Production Efficiencies of Marine Aerosol Generated from Sargasso Seawater.

AMANDA FROSSARD, Tret Burdette, Rachel Bramblett, William Keene, John Maben, Joanna Kinsey, David Kieber, Steven Beaupre, *University of Georgia*

Atmospheric aerosol particles play important roles in directly and indirectly influencing global climate, through absorption and scattering of radiation as well as acting as cloud condensation nuclei (CCN). The ability of particles to act as CCN depends on their size and chemical composition, and the number of CCN modulates cloud droplet microphysics. Primary marine aerosol particles are emitted directly from wave breaking and bubble bursting at the sea surface and may contribute to CCN in the marine boundary layer. The number of particles emitted, as well as the physical and chemical properties of these particles, are dependent on a number of factors, including the physical and biochemical conditions of the seawater. Here, we show that the number production efficiency (PEnum) and the surfactant properties of primary marine aerosol particles vary as a function of season and resulting seawater physiochemical properties, while the mass production efficiency (PEmass) remained relatively constant. In summer 2021 and winter 2023, sea spray particles were produced using a marine aerosol generator on board the *R/V Atlantic Explorer* in the Sargasso Sea. PEnum and PEmass were calculated from size distributions and air entrainment rates. The average PEnum was ~2 times higher in the summer compared to the winter (411 x 10^6 L^{-1} and 200 x 10^6 L^{-1}, respectively). The number size distributions were also shifted in the summer compared to the winter with a lower peak in PEnum diameter in the summer (52 nm) compared to the winter (64 nm). Seasonal differences in seawater physiochemistry likely contributed to the differences in PEnum. The lower sea surface temperature in the winter may have contributed to a higher seawater surface tension and altered bubble properties at the sea surface. Additionally, the concentrations of chlorophyll a were low overall but slightly higher in the winter, indicating different mixing profiles and potential differences in bubble properties. These seasonal differences demonstrate that PEnum will also vary widely for different seawater types and depend largely on the physicochemical properties of the seawater.

3AC.4

Connecting the Physicochemical Properties with Cloud Condensation and Ice Nucleation Activities of Secondary Organic Aerosol (SOA) Formed through Multiphase Chemical Reactions.

SINING NIU, Janie (Yeaseul) Kim, Christopher Rapp, Miska Olin, Zezhen Cheng, Xiaoli Shen, Gregory W. Vandergrift, Yuzhi Chen, Claire E. Moffett, Gourihar Kulkarni, Alla Zelenyuk, Swarup China, Jason Surratt, Daniel Cziczo, Yue Zhang, *Texas A&M University*

Current knowledge regarding the climate impact of secondary organic aerosol (SOA) are still not well understood. A primary reason is the limited knowledge of SOA serving as cloud condensation nuclei or ice nucleation particles due to their complex physicochemical properties and formation mechanism.

Here, we conducted chamber experiments with multiphase reactions of SOA generation from oxidation products of biogenic volatile organic compounds with neutral (ammonium sulfate) and acidic (ammonium bisulfate) seeds. We investigated the impact of seed acidity and physicochemical properties of SOA on their cloud formation.

The concentration and chemical composition of the SOA were determined by a High-Resolution Aerosol Mass Spectrometer (HR-AMS) and a Nanospray Desorption Electrospray Ionization (nano-DESI) coupled with an Orbitrap mass spectrometer. The morphology and phase state of SOAs were analyzed with a Scanning Electron Microscope (SEM). The miniaturized version of the Single Particle Laser-Ablation Time-of-Flight mass spectrometer (miniSPLAT) coupled with an evaporation chamber provided the volatility distribution of the SOA. The cloud condensation and ice nucleation activities of the SOAs undergoing multiphase reactions were measured by a Cloud Condensation Nucleus Counter and a Continuous Flow Diffusion Chamber in real-time to derive hygroscopicity parameter κ and ice freezing fraction, respectively.

Our result suggested that 20% of the inorganic sulfate was converted to organosulfates (OS) based on sulfate apportionment with AMS measurements, when reacting under the atmospherically relevant acidity. The sulfate equivalent mass fraction of OS was also higher with acidic seeds with the result from AMS being qualitatively consistent with the nano-DESI analysis. The κ of the bulk SOA was highly dependent on the volume fraction of organic aerosols. However, with the same organic fraction, the κ was lower under acid environment due to the higher concentration and lower κ of OS. The INP frozen fraction was higher for α-pinene-derived SOAs with acidic seeds due to the abundant OS formed and its higher viscosity, validated by the SEM images. Our study concludes that models should include the OS generation in SOA formation to constrain the uncertainties related to SOA-cloud interaction.

3AC.5

Parameterization of the Separation Relative Humidity in Submicron Aerosol Particles.

MIRIAM FREEDMAN, Qishen Huang, Kiran Reddy Pitta, *The Pennsylvania State University*

Liquid-liquid phase separation (LLPS) of atmospheric particles composed of organic and inorganic components has the potential to significantly impact climate, air quality, and human health. However, the complex composition, small size, and history-dependent properties of these aerosol particles results in great uncertainty in aerosol phase state for modeling atmospheric processes. In this study, we worked with model submicron aerosol particles composed of organic compounds mixed with ammonium sulfate and established a parameterization for the separation relative humidity (SRH) that accounts for the chemical composition, particle size, and equilibration time. We evaluated different variables that describe chemical composition: O/C ratio, partition coefficient, solubility, and polarizability. We found that the O/C ratio and polarizability can be used to distinguish homogenous vs. LLPS morphologies. Polynomial fittings show that the O/C ratio fits the SRH of micrometer droplets best, whereas the partition coefficient provides the best fit for the SRH of submicron aerosol. By using a scaling factor to translate the parameterization for SRH of micrometer droplets to the SRH for submicron aerosol particles, we incorporate the effects of size and the equilibration time on LLPS. Our parameterization will aid in modeling SRH, potentially leading to more accurate predictions of aerosol mass, optical properties, water uptake, and heterogeneous chemistry.

3AC.6

Exploring the Temperature- and Humidity-Dependent Viscous Properties of Organic and Mixed Organic-Inorganic Aerosol Particles: Impacts on Water Diffusion and Interpreting Chamber Studies.

RYAN D. DAVIS, Kyle McMillan, Christian Pattyn, Teresa Palacios Diaz, Katie Morton, Craig Sheldon, Samantha Kruse, Kyuhaeng Lee, Nicole Riemer, Matthew West, Cara Waters, Ali Alotbi, Katherine Kolozsvari, Andrew Ault, Jake Zenker, Lekha Patel, James F. Davies, *Sandia National Laboratories*

Aerosol particles can exhibit chemical and physical properties that are not observed in bulk. One reason for the unique properties of aqueous aerosol particles is that they can achieve extremely high solute concentrations not replicable under bulk conditions. For example, when aqueous aerosol particles are exposed to low relative humidity, solute concentrations can become higher than the water content, blurring the distinction between solute and solvent. This low water content can promote ultra-viscous or gelatinous phase states. Such viscous phase states are important because they can impact heterogeneous reactivity, hygroscopicity, mass transport of solutes, and the shape factor of coagulated particles. Aerosol viscosity is thus an important property to understand to predict the physico-chemical evolution of aerosol particles in the atmosphere and within controlled chamber studies. However, the viscosity of complex, multi-component aerosol systems is not fully understood.

Here, we discuss experimental and computational efforts to study the viscosity of supersaturated aerosol particles and its effects. To characterize aerosol viscosity, we use a temperature and humidity controlled electrodynamic balance. We explore the viscosity of organic and mixed organic-inorganic aerosol, with a particular focus on organic-inorganic systems where supramolecular interactions can lead to ultra-viscous and gelatinous phase states. The implications of aerosol viscosity on water diffusion and experimental observations of coagulation in chamber studies will be discussed. We show that viscosity and diffusion do not have a straightforward relationship for gelatinous particle phase states. Further, we compare the coagulation of vitreous and liquid aerosol particles to examine the impact that viscosity can have on processing data from chamber studies where coagulation is expected to influence the particle number and size distribution. Combined, these studies explore the impact of aerosol viscosity from the molecular level to aerosol population scales.

SNL is managed and operated by NTESS under DOE NNSA contract DE-NA0003525.

3AP.1

Quantification of Face Seal Leakage Using Parallel Resistance Model. Buddhi Pushpawela, PETER CHEA, Ryan X. Ward, Richard Flagan, *California Institute of Technology*

Masks and respirators afford varying degrees of protection to the person wearing them. The degree of protection depends upon the material (filter medium), the design and construction of the masks, manufacture, fit of the mask (how well it seals to the face), the nature of the particles that carry the virus, the respiration rate, as well as the percentage of particles penetrating through the face seal leakage, the total flow rate through the filter medium and other factors. Therefore, identifying the leaking places of masks and quantifying the leakage flow rate is important to estimate the protection.

In our study, we hypothesized a model to quantify the leakage flow rate through the face mask based on a parallel resistance model. We used Ohm's law as an analogy for the pressure leakage rate. The tests were performed in two ways; (i) mask material test, in which all masks were sealed to a flange to measure transmission through a full mask and prevent leakage around the edges (ii) mannequin mask test, in which masks are fitted to a mannequin head tightly. In this study, we have tested four different classes of masks: NIOSH-certified N95 Face Filtering Respirators (FFRs), KN95 masks, 3-ply, pleated, disposable procedure masks, and cloth masks. For all the FFRs and masks, the pressure drop was measured at eight different flow rates between 5 and 85 LPM, and it was increased linearly with the total flow rate ($r^2 > 0.98$). The results of the study showed that the leakage flow rate was 10% of the total flow rate, even for the best-fitted N95 FFRs and KN95 masks. They showed higher resistance to the leaks. The procedure masks and cloth masks showed a leakage flow rate of 25% of the value of the total flow rate, quite a large proportion of the flow. They had lower resistance to leaks. This parallel resistance model can help improve mask design and obtain better mask sealing.

3AP.2

Effect of Lagrangian Time Scales and Reynolds Number on the Prediction of Droplet Penetration through Vertically Oriented Turbulent Pipe Flows. ZACHARY MILANI, Edgar Matida, Leonid Nichman, R. Timothy Patterson, *Carleton University*

Aerosol deposition is a known bias in many common two-phase flow scenarios for example when pollen or dust accumulates in ventilation ducts, pharmaceutical aerosols are lost in the upper respiratory tract, and during the deposition of solid-phase combustion emissions inside of sampling systems. In these cases, numerical simulations can help to accurately predict aerosol deposition and losses. Using an eddy interaction model (EIM) to simulate aerosol deposition is attractive when compared to the time-consuming and computationally expensive direct numerical simulation (DNS) and large eddy simulation (LES) methods. There are, however, still challenges associated with using EIMs e.g., turbulence anisotropy treatment near pipe walls and the choice of proper Lagrangian time scales. To investigate these, a fundamental experiment studying droplet penetration in a vertically oriented turbulent pipe flow was simulated using a Lagrangian standard random-walk EIM code that was developed in house. Two Reynolds numbers (ReD = 5,300 and 19,000) were simulated using flow statistics (i.e., mean velocities, root mean square fluctuation velocities, and turbulence dissipation rate) that were obtained from DNS data found in the literature. These one-way coupled simulations involved the release of thousands of monodisperse droplets ranging from 1 to 27 µm into the computational domain. Improvements to droplet penetration estimates were achieved in previous work (flow simulations of ReD = 11,700 and 37,700) by introducing new eddy time scales based on the ratio of Lagrangian and moving Eulerian time scales, and the dissipation and velocity fluctuations normal to the walls. These time scales are further developed and systematically tested across a wider range of scenarios in this work. Additional random-walk models are implemented and compared to the standard model used in the original work.

3AP.3

Diffusivity of Small (< 10 nm) Nanoparticles in Air by Fully Atomistic Molecular Dynamics. Katerina Karadima, Dimitrios Tsalikis, Vlasis Mavrantzas, SOTIRIS E. PRATSINIS, *ETH Zurich, Switzerland*

Despite rigorous treatments of nanoparticle (NP) dynamics in gases, the NP diffusivity in the crossover regime from molecules to small NPs remains still poorly understood. Experiments in the past have attempted to address this regime by employing micron-sized particles and operating at low pressures in order to maintain the large Knudsen numbers (Kn > 10) in this regime. Here diffusion coefficients of tiny (from 0.4 to about 7 nm in size) fullerene and silica particles in air are obtained from molecular dynamics (MD) simulations wherein both particles and gas molecules are considered in their full atomistic representation [1]. The MD-derived diffusivities show systematic deviations from the Stokes-Cunningham-Millikan equation which become most pronounced as the nanoparticle size approaches that of gas molecules. A better description of the simulation results for particles larger than 2 nm is offered by the Epstein-based modification of Fernández de la Mora et al. [2], which makes use of the collision diameter instead of the equivalent spherical diameter of the particle and assumes inelastic collisions of rigid bodies captured through an arbitrary accommodation coefficient. The diffusivities for particles below 2 nm are not described well by the Tammet [3] and other formulations either. A modification of the Stokes-Cunningham-Millikan expression is proposed, which can describe NP diffusivity accurately from the free molecular to continuum regime.

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[2] Fernández de la Mora, J., De Juan, L., Liedtke, K., and Schmidt-Ott, A. (2003). Mass and size determination of nanometer particles by means of mobility analysis and focused impaction. *J. Aerosol Sci.* **34**, 79–98.
[3] Tammet, H. (1995). Size and mobility of nanometer particles, clusters and ions. *J. Aerosol Sci.* **26,** 459–475.

3AP.4

Implementing Aerosol Coagulation in the QUIC-Fire/QUIC-Smoke Model. HANNAH BRINK, Sara Brambilla, Matthew Nelson, Kyle Gorkowski, Liam Wedell, Diego Rojas Blanco, Katherine Benedict, *Los Alamos National Laboratory*

The QUIC (Quick Urban and Industrial Complex) model uses the Lagrangian random-walk method to determine the transport and dispersion of plumes. There are existing physics in the model for atmospheric aerosols, mainly for atmospheric deposition and dosage. QUIC-Fire and QUIC-SMOKE are sub-models that determine the extent of fire spread and production of smoke. This model is currently missing aerosol effects such as nucleation, condensation, and coagulation. The current research to integrate these effects into the model is focused on the coagulation of particulates released by combustion. The intent is to determine general coagulation equations for the QUIC model and ultimately apply them to PM2.5 particles, their concentration, and their impacts on plume behavior after a fire event.

3AP.5

Review of Aerosol Forces Under Nonstandard Conditions: Modeling and Applications. REN GARITY, James Henry, Andrew Metcalf, John Saylor, Sarah Suffield, *Clemson University*

When discussing forces on aerosol particles under standard conditions, gravity and inertia are often emphasized as the "major" forces affecting settling and deposition. However, under nonstandard conditions, such as environments with steep temperature gradients, high humidity, or turbulent flow, other forces can attain the same order of magnitude as gravity and inertia. These "minor" forces, such as diffusiophoresis, thermophoresis, Stefan flow, and Saffman lift, can significantly affect particles under nonstandard conditions, especially on particle sizes of less than one micron.

In this talk, we will introduce a review of forces in addition to gravity and inertia that can have significant effects on particles with diameters less than one micron under nonstandard conditions. Along with our review of the forces, we have also developed a MATLAB code and app, which we have named the Aerosol Calculator Application for Theoretical Modeling (AeroCATm). AeroCATm has advantages over other box modeling and chemistry applications as it has the capacity to calculate psychrometric properties of air, and therefore accounts for nonstandard conditions. The purpose of AeroCATm is to compare the magnitudes of various forces affecting deposition under short-range transport conditions, with the goal of helping users determine what environmental factors will be most relevant for their situation.

In this talk, we will also discuss applications of our findings. In terms of its applications, AeroCATm has the flexibility and capability to handle a variety of environments. Its primary reason for development is quantifying sea salt aerosol deposition in spent nuclear fuel dry cask storage containers, which involves a hot, potentially high-humidity environment under a transition flow regime. These conditions can also be present in industrial processes such as dust collectors and dryers, and examples of these situations will be provided to showcase AeroCATm's performance.

3AP.6

Exploring the Effects of Inelastic Collisions and Ion-Gas Energy Exchange on Electrical Mobility. CARLOS LARRIBA-ANDALUZ, Viraj Gandhi, *IUPUI*

Recent advancements in ion mobility spectrometry (IMS), exemplified by systems like the Structure for Lossless Ion Manipulation (SLIM), now operate with unprecedented precision. This level of precision allows for ion separations that challenge existing theoretical frameworks. Understanding these separations often requires diving into complex algorithms and higher-order approximations to grasp how internal degrees of freedom affect mobility. Specifically, it requires a deeper understanding of how collisions with the gas affect the exchange of angular, linear, and internal momentum. To shed light on these intricate energy exchanges, we have developed the IMoS 2 software. This software closely mirrors experimental conditions and is based on complex kinetic gas theory rooted in statistical mechanics. Within this framework, ions are surrounded by a non-equilibrium (NVT) ensemble of gas molecules, interacting as they move through the medium under external forces. A recent addition to the software enables ion vibration using a custom-integrated MM3 forcefield. This advancement allows for the study of energy exchange among the various internal degrees of freedom of ions and gas. The internal velocity distributions (rotational and vibrational) can be obtained, and more importantly, their change with the electric field probed, which is akin to solving the WUB equation for all-atom systems and hence precise mobility shifts can be explored. Initially, due to collisions with the gas and consequent heating, the ion has a period of relaxation before attaining an internal equilibrium temperature akin to its translational temperature. This equilibrium temperature might never be reached for large ions and fast varying fields suggesting the appearance of a fourth temperature: one for the gas, two for translation (longitudinal and transversal) and one for the internal degrees of freedom. This fourth temperature might be a requirement for the study of larger molecular systems in varying fields to obtain accurate mobilities and correctly calibrate instruments.

3BA.1

Molecular-based Comparison of Bioaerosol Sampling Instruments. NOHHYEON KWAK, Mohammad Washeem, Yang Wang, Chang-Yu Wu, Jiayu Li, *University of Miami*

The composition of bioaerosol is a crucial parameter in the transmission of pathogenic diseases, and molecular-based analysis is a powerful tool for identifying the biological composition of aerosols. Another important tool in understanding transmission is the bioaerosol sampler, which plays a pivotal role in capturing airborne microorganisms as a function of size. However, selecting a proper bioaerosol sampler is hard since the size-dependent collection efficiency affects the bioaerosol characteristics and biological diversity varies with capturing size ranges. Indeed, previous studies showed different bioaerosol diversity among samplers operating on different principles.

This study aims to compare bioaerosol samplers through molecular-based analysis of the samples collected by these samplers. We evaluated three popular sampling instruments, i.e., a swirling aerosol collector (Biosampler®, SKC Inc.), a water condensation growth tube bioaerosol sampler (SPOT sampler, Handix Inc.), and a cascade impactor (Sioutas impactor, SKC Inc.). We compared their collection efficiency and microbial diversity using 16S rRNA gene amplicon sequencing.

The Biosampler was easy to deploy with rapid sampling but exhibited lower collection efficiency than the SPOT sampler ($p > 0.05$). The SPOT sampler demonstrated the best collection efficiency across size ranges among the three samplers but necessitated extended sampling durations to exceed the detection limit for molecular analysis due to its low flow rate (1.5 Lpm). For the filter-based sampler, the Sioutas impactor provided valuable size information but showed different microbial diversity due to different collection materials. Our analysis employed DNA sequencing to assess bacterial diversity, revealing distinct variations among samplers. Principal Component Analysis (PCA) and Beta diversity using the Bray-Curtis method highlighted distinctive microbial compositions associated with each sampler, emphasizing the importance of informed selection for accurate representation.

This comprehensive comparison will elucidate the strengths and limitations of commonly used bioaerosol samplers, guiding researchers in selecting appropriate tools for diverse sampling scenarios.

3BA.2

Association between In Situ Ventilation and Human-Generated Aerosol Exposure in Meatpacking Plants during the COVID-19 Pandemic. JOSHUA L. SANTARPIA, Josephine Lau, Debayan Shom, Shanna A. Ratnesar-Shumate, Eric Carnes, George Santarpia, Vicki Herrera, Danielle N. Rivera, Daniel N. Ackerman, Ashley R. Ravnholdt, John Lowe, Athena Ramos, *University of Nebraska Medical Center*

During the COVID-19 pandemic, meatpacking workers were disproportionately affected by disease. Large outbreaks at meatpacking facilities resulted in severe economic impacts, loss of life and threatened the food security of many nations. Throughout the pandemic much work was done to understand and prevent these outbreaks. In this study, a system evaluation of the ventilation and measurements of human-generated respiratory aerosol were combined to investigate and identify the areas of highest risk for disease transmission. These findings confirm that improved ventilation reduces exposure to human generated aerosols, including those that may contain infectious agents, such as SARS-CoV-2. Furthermore, it suggests the areas of greatest risk are likely the common welfare areas, such as cafeterias and locker rooms, where ventilation is poorer, mask wear is reduced and large number of people congregate together. Furthermore, it also suggests that the ventilation in packing areas of the plant, designed for food safety, is sufficient to reduce exposure and likely helped to minimize transmission in those spaces. Based on this, two approaches may be taken to minimize the likelihood of exposure to potentially infectious aerosols: improving mechanical ventilation and/or adding mitigations such as portable HEPA filters and applying administrative practices that minimize large congregations of people in poorly ventilated spaces. Importantly, this work demonstrates a method for in situ measurements of human-generated particles that can be used more broadly to understand exposure and risk in a variety of occupied spaces.

3BA.3

Assessing the Infectious Potential of Accidentally Produced Aerosols 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*

Laboratory-acquired infections (LAIs) continue to pose a significant risk to laboratory workers, largely due to bioaerosols produced during routine procedures and accidents. Building on previous research, this study investigates the infectious potential of these aerosols by utilizing the nonenveloped viral surrogate, MS2 bacteriophage. The choice of MS2 bacteriophage allows testing of whether culturable microorganisms can be transmitted through the aerosols quantified in preliminary fluorescent tracer studies. A specialized chamber equipped with a cascade impactor, an optical particle counter, and a separate filter facilitated the assessment of aerosol production during selected routine procedures and simulated mishaps. The samples were analyzed using quantitative PCR and plaque assays to determine the presence and viability of the aerosols captured. This research enhances understanding bioaerosol dynamics within laboratory environments, potentially contributing to improved safety protocols and protective measures for laboratory personnel.

3BA.4

Biological Aerosol Field Trial: Exploring a UAS Biological Collection Point Sensor and Its Interoperability with Standoff Technology. BLAKE BECKMAN, Sylvie Buteau, Blaine Fairbrother, Amanda Weiler, Cara Bourgeois, Drew Robinson, Denis Nadeau, *DRDC Suffield Research Centre*

Defence Research and Development Canada (DRDC) is actively pursuing solutions in detection and identification of Chemical, Biological, and Radiological (CBR) agents utilizing a variety of techniques. The techniques used to provide advanced warning of a biological threat can range from fixed point sensor arrays, fixed stand-off technologies, and point sensors that have been integrated into Unmanned Ground and Aerial Vehicles (UGV/UAV). Each technology has limitations but a combination of these systems can leverage each other’s strengths, while minimizing the gaps, to provide a more complete understanding of the hazardous environment. Military personnel desire a rapid and concise understanding of the threat environment with field forward technologies in order to pursue the most appropriate path to mission success. In 2022, the Suffield Research Centre (SRC) held a biological aerosol field trial to explore the performance of a custom biological sampling point sensor designed for Unmanned Aircraft System (UAS) operations and its interoperability with standoff technology against biological threat simulants Bacillus atrophaeus (BG) and Ovalbumin (OV). The broad goals of the trial series were to understand how to obtain, consolidate, and transfer information on biological hazards for relevant decision makers. Some of the specific trial goals were to understand how to localize the source of the dispersal, track the dispersal in real-time, take a sample of the simulant in real-time, and post process the sample using field forward biological identification technologies. In total, 25 trials were conducted over four days that released BG and OV in varying concentrations to understand the interplay of tasking mobile point sensors from standoff technologies. Each specific trial also tried to determine the optimal placement of the UAV in the dispersal cloud, its duration in the cloud, and the relationship between the real-time sensor information of the UAV and the collection filter. The tools used to acquire and process the information include a LIDAR-based standoff system called BioSense, a Vertical Take-Off and Landing (VTOL) Unmanned Aircraft System (UAS) called the SkyRanger® R70, a fixed or mobile particle sizing and counting point sensor with a collection filter, Chemical/Biological (CB) Sensor Data Viewer software, Interaction Manager software, and UAS payload software.

3BA.5

Vertical Profiles of Fluorescent and Coarse Mode Particle Properties in the Colorado River Basin.

MARIA ZAWADOWICZ, Chongai Kuang, Olga Mayol-Bracero, Darielle Dexheimer, Mirtha Salatti, Russell Perkins, Paul DeMott, Jessie Creamean, Zezhen Cheng, Nurun Nahar Lata, Swarup China, *Brookhaven National Laboratory*

Bioaerosols—aerosols of biological origin—have wide-ranging atmospheric implications, including acting as ice-nucleating particles (INPs) to trigger ice formation in mixed-phase clouds. The potential impacts of bioaerosols on clouds depends on the vertical extent of biological material, yet vertical profiles of speciated aerosols can be difficult to measure without deploying dedicated bioaerosol samplers on airborne platforms such as an aircraft or a tethered balloon. This project investigated the vertical profiles of atmospheric bioaerosol concentrations during the Atmospheric Radiation Measurement (ARM) Surface-Atmosphere Integrated Laboratory (SAIL) campaign in the Colorado River basin. We deployed a novel, small-footprint fluorescence sensor alongside a Size- and Time-resolved Aerosol Collector (STAC) sampler and a collector for off-line quantification of immersion ice nuclei concentrations (IcePuck) on ARM's tethered balloon system (TBS) during spring and summer of 2023. We obtained simultaneous vertically resolved profiles of fluorescent aerosol concentrations, accumulation and coarse-mode size distributions, and samples of aerosol for subsequent analysis with high-resolution mass spectrometry and microscopy at the Environmental Molecular Sciences Laboratory (EMSL) for identification of specific particle morphologies. In addition, we also deployed a coarse-mode optical particle counter to measure vertically-resolved size distributions of particles up to 35 µm. Measurements of vertical profiles of coarse-mode particles are rare, yet essential to capture the vertical extent of surface-atmosphere interactions, as the coarse-mode particles tend to be limited to surface sources such as dust or pollen. This presentation will discuss a comprehensive characterization of spring and summertime aerobiome in the Colorado River basin, its vertical extent, and its interactions with clouds as a potential source of INPs.

3BA.6

Clouds and Meteorological Effects on Bioaerosol Particles: Insights From the Eastern Pacific Cloud Aerosol Precipitation Experiment (EPCAPE).

Abu Sayeed Md Shawon, KATHERINE BENEDICT, Kyle Gorkowski, Ryan Farley, Nevil Franco, James E. Lee, Manvendra Dubey, Lynn M. Russell, Allison Aiken, *Los Alamos National Laboratory*

In addition to their impact on local ecosystems and human health, bioaerosol - such as bacteria, pollen, and fungal spores - can modify cloud properties when activated as cloud condensation nuclei (CCN). To investigate the interaction between clouds and bioaerosol particles near a coastal city, during the EPCAPE Partitioning Thrust by Los Alamos National Laboratory (EPCAPE-PT-LANL), we deployed a ground-based virtual impactor (GCVI, Brechtel) and a wideband integrated bioaerosol sensor (WIBS-5, DMT) at Mt. Soledad (La Jolla, California) from October 20, 2023, to December 04, 2023. Under cloudy conditions, we collected cloud droplets using the GCVI and subsequently dried them. These dried cloud droplets represent the cloud droplet residuals. We compared the bioaerosol present in cloud residual with the cloud-free periods with the aerosol inlet Bioaerosols were measured using the WIBS that excites fluorescence particles larger than 0.5µm and smaller than 30µm in two wavelengths and measures the emission from these excited particles in two different wavebands. The specific excitation/emission wavelengths are optimized for detecting bioaerosol particles that fluoresce, commonly referred to as fluorescent bioaerosol particles (FBAPs). During the deployment, the number concentration of FBAPs reached as high as ~5 particles/cc and did not exhibit any diurnal variation for the total or by type. Within the size range of the WIBS, approximately 30% ± 10% of total particles were FBAPs, regardless of cloud presence. Although there were no apparent differences in the FBAP fraction, the absolute number concentration of FBAPs and the relative abundance of different types of FBAPs varied between cloud and no-cloud conditions, indicating that different FBAP types may be more prevalent in stratocumulus formation observed over land near the coast in the eastern Pacific. In our presentation, we will also delve into how meteorological factors such as temperature, relative humidity, etc., influenced the properties of FBAPs.

3CT.1 – INVITED

The 2023 NOAA Atmospheric Emissions and Reactions Observed from Megacities to Marine Areas (AEROMMA) Project: Overview and Selected Preliminary Results. Patrick Veres, Andrew Rollins, Carsten Warneke, Rebecca Schwantes, Brian McDonald, ANN M. MIDDLEBROOK, The AEROMMA Team, *NOAA Chemical Sciences Laboratory*

To improve our understanding of emissions and chemical reactions that affect climate and air quality, NOAA conducted the Atmospheric Emissions and Reactions Observed from Megacities to Marine Areas (AEROMMA) field campaign during the summer of 2023 to collect new observations from U. S. megacities and marine boundary layer regions. AEROMMA 2023 is a comprehensive study investigating marine and anthropogenic emissions that alter tropospheric composition using the NASA DC-8 aircraft and was part of the combined AGES+ (AEROMMA+CUPiDS, GOTHAAM, EPCAPE, STAQS and others) umbrella encompassing a multi-agency collaboration with other related field projects.

For the marine portion of AEROMMA, the DC-8 aircraft flew 4 flights over the ocean near the U. S. West Coast, focusing on marine biogenic sulfur species and marine cloud chemistry. Dimethyl sulfide emissions and loss processes were investigated to better understand the mechanisms involved in forming terminal products such as sulfur dioxide, methane sulfonic acid, and non-sea-salt sulfate. State-of-the-art measurements of hydroperoxymethyl thioformate, a recently discovered intermediate, were obtained to follow yields and fates of dimethyl sulfide. Additional aircraft maneuvers around clouds provided insight into the roles that the marine clouds can play in these processes.

For the urban portion, the aircraft was flown to investigate air quality and greenhouse gases in New York (4 flights), Chicago (5 flights), Toronto and Detroit (2 flights), the California Central Valley (2 flights), and Los Angeles (3 flights). The DC-8 aircraft played a key role as an in-situ observation platform in close coordination flying under remote sensing instruments aboard the NASA G-V and G-III aircraft and NASA's TEMPO satellite. The flights were used to determine emissions as well as ozone and secondary aerosol formation. This presentation will give a brief overview of AEROMMA and present a sampling of science results related to aerosols, clouds, chemistry and air quality.

3CT.2

A Pseudo-Lagrangian Perspective on New Particle Formation and Growth Observed in Urban Outflow Plumes during AEROMMA. EN LI, Charles Brock, Andrew Rollins, The AEROMMA Team, Shantanu Jathar, Jeffrey R. Pierce, *Colorado State University*

New particle formation (NPF) events, especially in urban settings, have mostly been observed from ground sites and offer limited information on the evolution of aerosol size distribution within the NPF plume. Traditional NPF precursor gases such as H_2SO_4 (from SO_2 oxidation) and mobile sources of volatile organic compounds (VOCs), as well as an non-traditional class of volatile chemical product (VCP) VOCs play an important role in urban air pollution and contribute to secondary organic aerosol (SOA) formation, either through NPF and increase the particle number concentration or through growth by condensation and increase the particle mass concentration. As part of the synergistic effort by AGES+ to understand the emerging role of VCPs in urban air quality, the Atmospheric Emissions and Reactions Observed from Megacities to Marine Areas (AEROMMA) campaign made a suite of gas- and particle-phase measurements over US megacities and Toronto. Using the AEROMMA dataset, we focus on cases of pseudo-Lagrangian sampling and investigate the contribution of traditional and non-traditional NPF precursor gases to the particle size distribution in urban outflow. In our preliminary results, we identify an urban NPF event on August 1, 2023 around Chicago with the median particle diameter growing from ~7 nm in the source region to ~25, ~50, ~90 nm approximately 30, 90, and 160 km downwind, respectively. Back-trajectory calculations, in addition to Laser Induced Fluorescence (LIF) SO_2 measurements and VOC measurements from the PTR-ToF-MS and LToF-CIMS mass spectrometry instruments, suggest nucleation is initiated in SO_2-rich industrial outflow from Gary, IN; and subsequent growth is promoted in VCP-rich urban outflow from Chicago, IL. Complementary work uses the Statistical Oxidation Model coupled with the TwO Moment Aerosol Sectional (SOM-TOMAS) aerosol microphysics model to evaluate the individual contribution of various traditional and non-traditional semivolatile precursor gases to NPF and subsequent growth.

3CT.3

Evaluation of In-Situ Aerosol Composition and Optical Properties Measurements from the 2023 AEROMMA Airborne Field Mission to Validate and Improve Satellite Data Products. HAN N. HUYNH, Adam Ahern, Ming Lyu, Charles Brock, Xiaoli Shen, Justin Jacquot, Daniel Cziczo, Alison Piasecki, Ann M. Middlebrook, Caroline Womack, Georgia Michailoudi, Joshua P. Schwarz, Daniel Murphy, *CU-CIRES/NOAA CSL*

One of the primary objectives of the Atmospheric Emissions and Reactions Observed from Megacities to Marine Areas (AEROMMA) 2023 field mission was to measure aerosol and trace gas properties to help evaluate and improve the satellite products of the Tropospheric Emissions: Monitoring of pollution (TEMPO) instrument. There was a comprehensive suite of instruments on the NASA DC-8 aircraft, including measurements of aerosol size distribution (3 nm–50 um), aerosol chemical composition (from both single particle and aerosol mass spectrometers), and aerosol optical measurements over the ultraviolet and visible wavelengths. The DC-8 aircraft also performed multiple vertical profiles that provided important points of comparison between the *in-situ* and remote sensing measurements, such as direct comparison of column-integrated aerosol optical depth (AOD) and aerosol layer height between the *in-situ* and satellite-derived values.

We will give an overview of the aerosol instruments onboard the aircraft and our progress in combining the *in-situ* aerosol microphysical, chemical, and optical measurements for a complete aerosol vertical profile. In addition to the satellite and ground-based remote sensing measurements (e.g., Aerosol Robotic Network, AERONET), there was a NASA G-V aircraft with a down-looking, high-spectral-resolution lidar (HSRL), in patterns in the vicinity of New York, Chicago, and Los Angeles. These active remote sensing measurements at ambient RH conditions will be compared to the extinction calculations at ambient RH derived from our dry, *in-situ* aerosol measurements on the DC-8. The HSRL data are also used to derive aerosol types (e.g., smoke, dust, urban pollution, sea salt, and mixtures). The AEROMMA *in-situ* composition and size distribution data will provide direct validation of the accuracy of and underlying assumptions of aerosol retrievals from the HSRL as well as from TEMPO and AERONET.

3CT.4

PM1 Liquid Water and pH Determined with a Thermodynamic Model for the AEROMMA Field Campaign. MAGESH KUMARAN MOHAN, Alison Piasecki, Ann M. Middlebrook, Amy P. Sullivan, Emily Lill, Ilana Pollack, Stelios Kakavas, Spyros N. Pandis, Athanasios Nenes, Rodney J. Weber, *Georgia Institute of Technology*

Particle acidity, or pH, governs numerous aerosol processes that impacts aerosol concentration, composition, and toxicity. Here we assess fine particle water and pH over several cities across the US using aircraft measurements from the AEROMMA study in summer 2023. Liquid water content and pH, based on both ionic and organic species, were predicted with a thermodynamic model (ISORROPIA-LITE) with gas and PM1 composition measurements, and meteorological parameters (RH >40% and temperature) as input variables. The model was evaluated by comparing predicted and observed NH3-NH4+ partitioning, and a good correlation was found (Slope=0.91, R2 = 0.81). Based on the analysis with preliminary data, the pH was consistent across all the cities at altitudes between 1 and 12 kft and ranged between 1.6 to 3.1 with an average pH of 2.3 ± 1.2 units for the study. This is slightly less acidic compared to previous ground based and aircraft studies. Water content associated with organic species on average made up 60% of the total LWC, while sulfate on average contributed 90% to the inorganic water fraction. However, the pH predicted without considering organic water was only about 0.4 units lower. Layers of high smoke levels were intercepted over urban areas in some flights. The average pH in those smoke layers (altitudes 4 to 10 kft) was about 1 unit higher than in areas with less smoke (average pH of 2.2). NO3- concentrations were generally low in all regions studied (average concentration 1 µg/m3) and 1 µg/m3 higher in the smoke plumes studied. Previous studies have reported pH of ~ 6 in fresh smoke, while these results are consistent with studies of more aged smoke. Further analysis with more accurate data will provide additional insights on pH and LWC over cities, in smoke layers and more remote continental regions.

3CT.5

Estimating Surface PM2.5 Concentrations and Chemical Composition from High Spectral Resolution Lidar Retrievals Using the HSRL-CH Methodology.

Bethany Sutherland, NICHOLAS MESKHIDZE, *North Carolina State University*

Remote monitoring of surface concentrations of particles with an aerodynamic diameter under 2.5 µm ($PM_{2.5}$) remains challenging as the hygroscopic growth and the resulting optical properties of aerosols depend on their chemical composition. High Spectral Resolution Lidar (HSRL) retrievals of aerosol intrinsic properties can be used to assign aerosol types (e.g., urban, smoke, fresh smoke, dusty mix, maritime, and polluted maritime). These HSRL-derived aerosol types can then be linked to likely chemical speciation using the GEOS-Chem model-based CATCH (Creating Aerosol Types from Chemistry) algorithm, developed in our research group.

Here we examine a recently developed HSRL-CH method to estimate surface $PM_{2.5}$ by leveraging HSRL-retrieved extinction and assigned aerosol types in combination with the GEOS-Chem/CATCH-derived aerosol type-specific chemical compositions. The data were acquired from 99 research flights conducted during the ACEPOL, SEAC4RS, DISCOVER-AQ California, DISCOVER-AQ Colorado, and DISCOVER-AQ Texas field campaigns. HSLR-CH derived concentrations and speciation are compared to hourly $PM_{2.5}$ concentrations and daily chemical compositions measured at U.S. EPA Air Quality System (AQS) sites. Generally, results using HSRL-CH compare favorably with the ground measurements-consistent with previously published results using DISCOVER-AQ BWC retrievals. The extension to include retrievals from five additional campaigns highlights the conditions best suited for success remotely deriving $PM_{2.5}$ using HSRL-CH, and several remaining challenges (e.g. cases of low mixing layer height or complex local meteorology). This analysis provides new insights into the suitability of GEOS-Chem/CATCH derived aerosol type-specific compositions for remotely deriving $PM_{2.5}$. Comparisons of HSRL-CH-derived chemical compositions with AQS speciation for each aerosol type will also be presented.

3CT.6

Altitudinal Gradient in Aging and Mixing State of Transported Saharan Dust in the Tropical North Atlantic Marine Boundary Layer: Insights from the MAGPIE Campaign.

SUJAN SHRESTHA, Hope Elliott, Nurun Nahar Lata, Zezhen Cheng, Swarup China, Edmund Blades, Devon Blades, Alyson Allen, Rebecca Chewitt-Lucas, Jesus Ruiz-Plancarte, Albert Ortiz, Thomas Eck, Pawan Gupta, Elena Lind, Willem Marais, Robert Holz, Jeffrey Reid, Andrew Ault, Cassandra Gaston, *University of Miami*

During the summer seasons, prevailing synoptic conditions facilitate the transport of Saharan dust across the Atlantic Ocean towards North America and the Caribbean, influencing biogeochemical cycles, climatic phenomena, and human health in important but poorly understood ways. Therefore, we present comprehensive aerosol physical and chemical measurements collected during the summer in 2023 at the University of Miami's Barbados Atmospheric Chemistry Observatory (BACO) during the Moisture and Aerosol Gradients/ Physics of Inversion Evolution (MAGPIE) campaign. In addition to in-situ measurements and bulk chemical characterization, aerosol samples were collected at ground-level and both above and below cloud base aboard the NOAA Twin Otter aircraft for single-particle analysis. These samples were analyzed using computer controlled-scanning electron microscopy/energy dispersive X-ray spectroscopy (CCSEM/EDX) to elucidate chemical mixing state, particle size, and sphericity. During the campaign, days preceding and following Saharan dust events were primarily influenced by sea spray particles followed by internally mixed dust and sea spray particles. Whereas, during the peak dust event day, characterized by elevated aerosol optical depth (AOD) of ~0.8 and dust mass concentration of ~120 µg/m3, the aerosol composition showed a significant fraction of externally mixed mineral dust followed by internally mixed dust and sea spray particles. Notably, a substantial fraction of submicron biomass burning, and organic aerosols were co-transported alongside the dust. Assessment of the vertical gradient of aerosol measurements revealed altitudinal gradients in size, aging and mixing state of Saharan dust and these results can be used to improve uncertainties in current climate models regarding dust's role on radiative effects and cloud processing in the tropical North Atlantic.

3IA.1

Indoor Organic Aerosol Formation Near Occupants in an Occupied Classroom Using Computational Fluid Dynamics Simulations.

SUWHAN YEE, Donghyun Rim, *Pennsylvania State University*

Understanding the formation and transport of particles in an occupied space is essential to lower human exposure to particles. The objective of this study is to advance the understanding of the formation of secondary organic aerosols (SOA) in environments characterized by thermal conditions indoors. The core of this study involves integrating the volatility basis set (VBS) model with computational fluid dynamics (CFD) simulations. The CFD model simulated SOA formations due to the ozone reaction with terpene in a standard classroom. The model's accuracy was validated using empirical data from existing measurement studies and a traditional well-mixed model. The study results show that the concentrations of SOA near occupants are lower compared to the ambient air in the room, whereas the concentrations of semi-volatile compounds are significantly higher in proximity to occupants. [dR1] This trend is mainly attributed to high temperature and buoyancy-driven thermal plume developed in the proximity of the occupants. The study further revealed a notable variation in indoor particle concentration[dR2] [dR3] , up to about 30%, despite consistent air exchange rates and average room temperatures. This variation is primarily because of distinct local airflow patterns and temperature gradients associated with cooling or heating of the occupied space.

3IA.2

Rapid Aerosol Infection Risk Prediction for a Classroom Using Computational Fluid Dynamics Simulation Coupled with Data-driven Machine Learning.

HYEONJUN LEE, Donghyun Rim, *Pennsylvania State University*

This study offers an exclusive analysis of airborne infectious disease transmission risks in classroom environments, employing Computational Fluid Dynamics (CFD) simulations to explore critical factors such as ventilation strategies, air change rates, occupant arrangements, source locations, and particle sizes. Through 224 generated simulation cases, this research also incorporates data-driven supervised learning methods—specifically, Long Short-Term Memory (LSTM) and Artificial Neural Networks (ANN)—for rapid airborne infection risk prediction. Key findings reveal that displacement ventilation decreases airborne infection risk by 49%-77% in comparison to mixing ventilation. Moreover, the conventional Wells-Riley model was identified as lacking in its ability to accurately predict spatial infection risks. The study further challenges the universally beneficial role of higher air change rates, revealing an increased risk of up to 166% for occupants seated in the back rows of a classroom when air change rates were elevated. The research also suggests that relying solely on physical distancing is insufficient in specific settings and emphasizes the need to consider other factors like airflow patterns. Lastly, while the ANN-based model struggled capturing the intricate relationship of inhalable particle number and infection risk, there is still a chance of improving the level of prediction. The results of this study can be used to inform HVAC system design and operation strategies to reduce the risk of infection transmission in indoor environments.

3IA.3

Multi-Zonal Modeling in a Residential Apartment Using Physics Informed Long Short-Term Memory Approach.

ALOK KUMAR THAKUR, Sameer Patel, *Indian Institute of Technology Gandhinagar*

Most IAP research focusing on modeling and material balance assumes well-mixed conditions, which is usually not the case, especially in bigger spaces. Studying the inter-zonal transport of pollutants and their governing factors provides critical insights into the fate and transport of pollutants from emission zones to different zones in a multi-zonal indoor space. The current work focuses on predicting PM concentrations in different zones of a residential apartment using PM levels measured by a monitor in one zone. The governing parameters here include inter-zonal flow and deposition rates. The work consists of two parts - (a) estimation of inter-zonal flow rates between different zones and (b) prediction of spatial PM concentrations using a deep learning model.

Inter-zonal flow rates are obtained using different optimization algorithms where initial conditions are based on the experimentally obtained datasets. The derived flow and deposition rates served as critical inputs for the subsequent stage, including predicting PM concentration in different zones from PM levels obtained from a single zone using a physics-informed long short-term memory approach (PI-LSTM) model. The ordinary LSTM models require a sufficient dataset to get trained and fail to adhere to the laws of physics. In contrast, PI-LSTM will require fewer datasets and will depend on physics constraints to improve the accuracy and reliability of the obtained results.

$PM_{2.5}$ and CO_2 transport experiments were performed to obtain the model's training and testing datasets. Validation of the results against the experimentally obtained data was done. Deposition rates for three zones are found using experimental datasets. Further, different optimization algorithms are tested to estimate the optimum value of the interzonal flow rate.

3IA.4

A New Methodology for Indoor PM2.5 Source Apportionment.

Shiva Nourani, HECTOR JORQUERA, *Pontificia Universidad Catolica de Chile*

Quantifying source contributions to indoor $PM_{2.5}$ has been limited by monitoring costs (Othman et al, 2022). Here we propose a new, cost-effective methodology. We apply FUSTA — FUzzy SpatioTemporal Apportionment (Jorquera and Villalobos, 2023)— to a database of indoor and outdoor $PM_{2.5}$ concentrations in classrooms of 19 schools, measured using low-cost sensors, to find the main spatiotemporal patterns (STP) in $PM_{2.5}$. We find four dominant STP in outdoor $PM_{2.5}$: regional, overnight mix, traffic, and secondary $PM_{2.5}$; indoor $PM_{2.5}$ has these same STP as counterparts plus another STP characteristic of indoor generated $PM_{2.5}$. These indoor STP show concentration peaks during activity hours due to housekeeping and children's activities.

On average, the overnight mix source contributes to indoor $PM_{2.5}$ with 11.5 $\mu g/m^3$, followed by secondary (9.9 $\mu g/m^3$), traffic (6.3 $\mu g/m^3$) and regional (4.8 $\mu g/m^3$) sources, respectively; indoor-generated contributions are 5.8 $\mu g/m^3$. A cluster wise indoor-outdoor $PM_{2.5}$ regression is applied to estimate STP-specific infiltration factors (F_{inf}) per school. Median and IQR for F_{inf} are 0.7 [0.62-0.9], 0.83 [0.7-0.89], 0.72 [0.64-0.81] and 0.76 [0.68-0.84] for regional, overnight mix, traffic, and secondary sources, respectively.

This cost-effective methodology can identify the indoor-generated contributions to indoor $PM_{2.5}$ —including their temporal variability — and estimate a source apportionment of the major sources contributing to indoor $PM_{2.5}$ concentrations. In the context of classroom environments, it allows to estimate children's exposure per source during school hours.

References:

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3IA.5

Reducing Infectious Disease Transmission in Operating Rooms.

Reza Daneshazarian, JEFFREY SIEGEL, *University of Toronto*

Operating rooms (ORs) are typically designed and operated to reduce the occurrence of surgical site infections (SSIs). Because of SSIs, hospital operating rooms (ORs) are typically maintained at positive pressure which can increase the risk of disease transmission within and to spaces outside of the OR when an infected patient is present. We conducted experiments and simulations in an OR with both a continuous source and an episodic source (a cough box) of simulated respiratory aerosol. The independent experimental parameters included pressurization status (positive vs. negative), healthcare worker (HCW) presence and activities, and anteroom presence or absence. The experimental results demonstrated the value of negative pressure for both reducing exposure to HCW as well as transmission to the sterile corridor outside of the OR (concentration reductions ranged from 1.2 – 63%, depending on location and experimental parameters). Positive pressurization was also associated with higher variability in respiratory aerosol concentrations in the operating table area. In general, negative pressure did not increase particle concentrations in the surgical site area. HCW activities impacted respiratory aerosol concentrations in the operating table area, but this impact was similar under both positive and negative concentrations. Independent of operating room pressure, an uncontrolled anteroom did not impact aerosol concentrations in the operating table area. The simulation results (validated with experimental results) demonstrated the value of controlling the anteroom pressure to minimize the transport of aerosols both into and out of the OR as well as reinforcing the similarity between positive and negative pressure for protection of the surgical site. Collectively, the results suggest that negative pressure should be considered for ORs, especially when operating on patients with known or suspected airborne infectious diseases.

3IA.6

An Aerosol Flame Photometer to Study Indoor Aerosol Dispersion.

JONATHAN SYMONDS, Julie Pongetti, Kristian Hoffman, Chris Nickolaus, *Cambustion Ltd*

The COVID-19 pandemic has underlined the need for good indoor ventilation. Yet many studies of its efficacy rely upon gas tracing even though the transport properties of aerosols and gases are very different; thus results from gases may not apply well to the study of disease transmission. Aerosols can be used as a tracer in indoor environments, and sodium chloride is a good candidate as it is considered safe, but Condensation Particle Counters (CPCs) cannot distinguish between the tracer aerosol and any existing background aerosol, for example from external traffic.

Flame photometry, the detection of the characteristic emission of light when chemical species are heated in a flame, has been used in standards for filter testing where NaCl is used as a test aerosol, and yellow light is emitted from the flame in proportion to the mass concentration of sodium sampled. We have recently developed a refined Aerosol Flame Photometer (AFP) instrument, with high sensitivity to NaCl and a fast temporal response. These properties make it an ideal tool to study dispersion of aerosols in indoor environments.

To test we nebulised and released into a small room NaCl, using 20% CO_2 as a carrier which also allowed gas tracing to occur using a fast response CO_2 analyser. The AFP was pre-calibrated for NaCl mass using an Aerodynamic Aerosol Classifier and a CPC. A CPC is also used in the room to count particles. We show here how the concentrations vary over time and with various ventilation strategies. The ratio of CPC to NaCl concentrations relates to the size of particles upon release, which varies slightly; however even if the size decreases due to evaporation after release, the mass of NaCl contained, and hence the AFP signal, is invariant and thus only depends upon dispersion and dilution in the air.

3IM.1

Measuring Surface Tension of Single Aerosol Particles Using Electrodeformation. THOMAS PRESTON, *McGill University*

Surface tension measurements are key to understanding the behaviors of atmospheric aerosols, especially concerning their role in cloud droplet formation and activation. Conventional tensiometry tools encounter significant difficulties with metastable states relevant to aerosols (e.g. supercooled, supersaturated) due to large sample volumes and the presence of surfaces. This work introduces an instrument designed to measure surface tension in a non-contact, humidity-controlled setting by employing a strong electric field to deform aerosol microdroplets.

Our method uses a dual-beam optical trap to hold single microdroplets between two electrodes. Upon application of a high voltage across the electrodes, microdroplets exhibit deformations on the order of tens of nanometers. These deformations are quantified through the analysis of morphology-dependent resonances that appear as sharp peaks in Raman spectra. This technique allows for the precise determination of surface tension in aqueous droplets containing inorganic and organic solutes commonly found in atmospheric aerosol particles.

We focus on water activities that correspond to supersaturated conditions, a domain largely unexplored due to measurement challenges. Our findings, where they can be compared to existing data, align well with previous results. The instrument, which does not depend on dynamic processes, is also capable of measuring surface tension in systems with viscosities exceeding 100 Pa·s, representing a major advancement over previous levitation-based methods.

3IM.2

Characterizing the Influence of Particle Coating and Volatility on the Differential Loading Compensation Parameter from a DualSpot® Aethalometer. RYAN POLAND, John Allen, Zachary McQueen, Rawad Saleh, Geoffrey Smith, *University of Georgia*

Aethalometers are widely used to measure concentrations and optical properties of black carbon (BC)-containing particles, highly absorbing combustion tracers that contribute significantly to climate change. These instruments operate by measuring the transmission of light through filters loaded with particles but are known to suffer from loading effects resulting in an underestimation of BC. In 2015, Drinovec et al. (2015) introduced DualSpot® technology, which provides a way to generate a real-time compensation parameter (*k*) to correct for the loading effect, using two filter spots sampling at different flow rates. Using a differential loading approach for calculating *k* based on the scheme of Virkkula et al. (2007), rather than the integrated loading approach of Drinovec et al. (2015), improves absorbance measurements. Here, we explore the potential use of these differential *k* values from a seven-wavelength AE33 aethalometer as indicators of particle coating and volatility. Specifically, we calculate a volatility factor (VF) using the ratio of extinctions from a pair of cavity ring-down spectrometers with and without a thermodenuder. We show how values of *k* and their wavelength dependence correlate with the VF for ambient aerosol (Athens, GA), and how these correlations may differ by season.

3IM.3

Carbon Quantum Dots for Direct Measurement of the pH of Aerosol Particles. KOMAL JASWAL, Victoria Adekunle, Miriam Freedman, *The Pennsylvania State University*

Continental aerosol particles have been predicted to be highly acidic based on their composition and thermodynamic models. The acidity of aerosol particles can have a significant impact on atmospheric visibility, climate, heterogeneous chemistry, human health, and biogeochemical cycles. The small size of aerosol particles makes pH measurement challenging. Here, we present a novel approach using carbon quantum dots (CQDs) as *in situ* fluorophores to directly measure the pH of individual droplets and droplet phases in the range of pH 1.5 – pH 3.5. The method involves two different types of CQDs, where orange emissive CQDs serve as an internal standard and blue emissive CQDs serve as the pH-sensitive probe. A calibration curve was constructed using the ratiometric fluorescence intensities of droplets of standard solutions to develop an assay of fluorescence emission intensities as a function of pH. The calibration curve was then used to determine the pH of model continental aerosol particles in the highly acidic range and to determine the effect of organic compounds of different pK_a values on the droplet pH. Our method demonstrates the capability of CQDs for real-time and direct measurement of the acidity of aerosol particles and their phases and thus provides an avenue to enhance our understanding of the physicochemical properties of atmospheric aerosol particles. The ability to directly determine aerosol pH holds a significant potential to parameterize thermodynamic models and refine predictions of aerosol properties.

3IM.4

Coupling of Photoionization Mass Spectrometry to Thermal Optical Carbon Analysis (EC/OC-Measurement) for Rapid PM-Characterization. Hendryk Czech, Patrick Martens, Paul Kösling, Marco Schmidt, Christopher Rüger, Thorsten Streibel, Sven Ehlert, Andreas Walte, Martin Rigler, Johannes Passig, RALF ZIMMERMANN, *Mass Spectrometry Centre;Rostock University/Helmholtz Munich*

At several air monitoring station worldwide, PM is routine sampled on quartz fiber filters and analyzed by thermal-optical carbon analysis (TOCA) for organic and elemental carbon (OC and EC). Individual OC- and EC-fractions are analyzed in the TOCA-process by stepwise heating of a small PM-loaded filter-punch. With the coupling of different photoionization and electron ionization mass spectrometry setups to the TOCA, additional information on average carbon oxidation state (OSC), content of polyaromatic hydrocarbons (PAH) or source specific markers are gained.

A subset of material evaporating during a temperature protocol is transferred to a time-of-flight mass spectrometer (TOFMS) prior to catalytic conversion for TOCA and ionized by either Single Photon (SPI)- or Resonance-Enhanced Multiphoton Ionization (REMPI). While REMPI provides a selective and sensitive detection of polyaromatic compounds including PAH, SPI refers to a more universal ionization technique capable to special features of PM sources.

A new hyphenated TOCA-REMPI/EI-TOFMS approach enables the simultaneous determination of toxic PAH and the OSC in PM. Similar to the high-resolution Aerosol Mass Spectrometer (AMS), the TOCA-REMPI/EI-TOFMS-approach provides quantitative results on organic matter, nitrate and sulfate. Furthermore, key isobaric ions C3H7+ and C2H3O+ at m/z 43, necessary to distinguish between oxidized and hydrocarbon-like organic aerosol, are separated due to a mass resolution of ~2,800. Simultaneously, the selective REMPI detection of toxic PAH was realized by a KrF laser with 248 nm radiation.

In a high resolution approach, REMPI is conducted directly in the C-Trap of a modified Orbitrap-MS for hyphenation to TOCA. Stored ions subsequently are injected into the Orbitrap-MS for mass analysis by pulsing of the C-trap. A high-resolution analysis of the evolved gases is achieved, allowing the resolution of isobaric aromatic systems and a direct sum formula assignment. This is particular important for studying photochemical degradation of polyaromatics or the speciation of sulfur containing compounds in combustion emissions.

3IM.5

Rapid and Sensitive Chemical Analysis of Individual Picolitre Droplets by Mass Spectrometry.

JIM WALKER, Bryan R. Bzdek, *University of Bristol*

Routine and sensitive chemical analysis is extremely challenging if the analyte of interest is rare or expensive to produce. We introduce a Single Picodroplet Mass Spectrometry approach allowing mass spectrometric analysis of picogram quantities of analyte contained within individual aerosol droplets, without the need for intermediary ionization devices. In the approach, individual picolitre droplets of known composition and size are reproducibly generated using a droplet-on-demand dispenser and guided to the mass spectrometer inlet using a linear quadrupole electrodynamic balance (LQ-EDB). The LQ-EDB is housed within an environmentally controlled sheath and a high-resolution imaging assembly allows droplets to be imaged during transit (i.e. to calculate the diameter). Ionization is accomplished using droplet assisted ionization, where rapid evaporation of an aqueous droplet within the mass spectrometer inlet leads to the formation of molecular ions. The technique permits discrete and rapid (10 Hz) sampling from a continuous stream of droplets, with no carry-over in the observed signal between individual droplets. Benchmarking studies of droplets containing aqueous solutions of peptides and other biological molecules demonstrate the approach is capable of routine analysis of samples containing as little as 2 pg of analyte, with the potential to go much lower. Picodroplet mass spectra show a significant reduction in spectral noise compared to electrospray ionization of the same solution. The effect of droplet size and analyte concentration on ion yield is explored, providing insight into the ionization mechanism. This Picodroplet Mass Spectrometry approach could have widespread applications for chemical analysis of scarce samples.

3IM.6

A New Spin on Colorimetric Measurement of Aerosol pH Using Aerosol Water Uptake.

CARA WATERS, Ali Alotbi, Katherine Kolozsvari, Andrew Ault, *University of Michigan*

Aerosol acidity is a critical property that dictates both the amount of aerosol mass and its chemical makeup. Aerosol pH influences the rate of condensed phase reactions, the uptake of gaseous organic species such as aldehydes and epoxides, and the development of phase-separated morphology. Thus, it is crucial to understand aerosol pH in different regions around the globe to accurately model the formation and evolution of aerosol particles in the atmosphere. Unfortunately, there are very few direct measurements of ambient aerosol pH due to the analytically challenging nature of these measurements. Our group has introduced a relatively low-cost method of measuring the bulk pH of size-resolved aerosol with colorimetric pH indicators. However, this method is infeasible for particles with low liquid water content that do not wet pH paper as well as particles whose pH falls outside the range of pH paper. Herein, we introduce a new collection method for the colorimetric pH method: a Spot Sampler (Aerosol Devices Inc.) growth tube increases particulate liquid water content before impaction onto pH paper. Combining the measured pH of the supersaturated aerosol and the water uptake of these particles, we can calculate the pH of aerosol particles before growth. The water uptake of particles in the Spot Sampler was quantified through a series of experiments measuring ammonium sulfate particle size distributions before and after the growth tube. To compare with previous methodology, pH measurements for lab-generated aerosol particles of varying pH were obtained with this new Spot Sampler-based colorimetric pH method and were compared with single-particle spectroscopic pH measurements based on conjugate acid-base equilibria. This work demonstrates that our expanded colorimetric method for pH measurement has significant potential for measuring the pH of bulk aerosol at sites around the world, improving our understanding of aerosol acidity and its spatial heterogeneity.

4JS.1

Nahin Ferdousi-Rokib, PhD Candidate in Chemical Engineering, University of Maryland College Park, Seeking Industry/ Postdoctoral Positions. NAHIN FERDOUSI, *University of Maryland, College Park*

My name is Nahin Ferdousi-Rokib and I am a PhD Candidate at University of Maryland College Park studying Chemical Engineering. Currently, my research focuses on how physicochemical properties of organic compounds (e.g., chemical structure, surface activity) influence mixed aerosol particles phase morphology, CCN activity and droplet growth. Throughout my PhD I have worked with both laboratory experiments as well as modeling. I have diverse experiences during my research career that will help me excel as a postdoc. I have experiences understanding both the chemical and physical properties of aerosols. During my PhD, I focused on the hygroscopicity of internally mixed inorganic-organic aerosols, starting with surface active binary mixtures and then moving to nitrogen containing aerosol mixtures. I would then model hygroscopicity by modifying thermodynamic principles, showing that organic chemical properties influence water uptake and CCN activity. I also developed modeling experience during a 6-month fellowship at PNNL. Apart from my research at UMD, I participated in undergraduate research at Lafayette College, focusing on the kinetics of brown carbon reactions as well as measuring particle coagulation from 3D printer emissions. I also have experience performing chamber experiments, focusing on particle growth under UV light, during my summer research experience at Columbia University.

I am seeking a post-doctoral or industry position. I would like to build upon my existing experimental and modeling skills in aerosol research, with a keen interest in participating in field campaigns. I am actively seeking positions at federal institutions and universities but am also open to industry positions as well. I anticipate finishing my degree in Spring 2025 and will be available for my new position in August 2025.

4JS.2

Raymond J. Leibensperger III, 4th Year PhD Candidate, Seeking National Lab Postdoctoral Position. RAYMOND LEIBENSPERGER III, *University of California, San Diego*

Growing up in Colorado, I was fascinated by the atmospheric phenomena around me and inspired by field trips to the National Center for Atmospheric Research. The fascination with the earth system developed into a love of the ocean, despite being in a land-locked state. This passion took me to the University of Miami where I double majored in marine science and applied physics and worked in Dr. Cassandra Gaston’s atmospheric chemistry lab studying the emission of toxins in lake spray aerosols. It was here I discovered naturally produced aerosols and fell in love with what I currently study—sea spray aerosols (SSA). I am currently an experimentalist working on bringing the ocean into the laboratory to investigate factors driving sea spray aerosolization in controlled studies. I use the new Scripps Ocean-Atmosphere Research Simulator which offers unparalleled environmental controls. I am currently in the process of relating laboratory measurements of SSA flux to emission schemes used in classic global climate models. Although I presently work as an experimentalist, next I hope to transition into the modeling sphere. One of the biggest gaps in our current approach to aerosol science that I see is a lack of intentional communication between the modeling and observational communities. We need more teamwork on the front end to augment what the other discipline cannot measure, to better inform observations and models. For my next career stage, I hope to transition to modeling, either focused on SSA or other natural aerosols, to begin understanding how models utilize the measurements that I’ve spent my PhD taking. I am anticipating a defense in the summer of 2025 and hopefully a postdoc position in late summer to early fall 2025. Long-term, I hope to return to CO, but I am keeping geographic options open for this next stage.

4JS.3

Garima Raheja, 5th year PhD, Seeking Opportunities in Energy/Data in Government, Academia or Private Sector.
GARIMA RAHEJA, *Columbia University*

Hi! I'm in the final year of my PhD candidacy at Columbia University in New York City, where I work on air pollution, community science, and international climate policy. I'm in the Westervelt Aerosol Group and previously worked on decarbonization at the White House, earth observations using satellites and fighter jets at NASA, living on a NOAA ship, and leading an environmental strategy consulting org in Berkeley. I sit on the BAAQMD Advisory Council, and I'm an AGU Community Science Fellow, Data for Progress Fellow, Lead Teaching Fellow at Columbia, and a State Department Air Quality Fellow. Recently, I was honored with the Dr. Devon T. Wade Mentorship, Service, and Advocacy Award, which is given annually to one PhD candidate at the Columbia University commencement. Previously, I have also been awarded the Women in Science Incentive Prize and the NSF Graduate Research Fellowship. I graduated with degrees in Data Science and Civil/Environmental Engineering from UC Berkeley where I was a Regents' and Chancellor's Scholar. When I'm not doing science, you can find me watching musical theatre on Broadway or picking up a new sport every few months. I'm looking for jobs in energy / climate / policy / finance, starting in Summer 2025. I'm open to postdocs, tenure-track positions, fellowships, or full-time jobs in NYC, San Francisco or Paris. I'm open to remote positions and excited about positions that involve working with stakeholders, especially internationally. Learn more about me on my website at graheja.github.io.

4JS.4

Ashley R. Ravnholdt, Graduate Student, Seeking Opportunities in Government, Private Sector, & Industry Within Biodefense and Bioaerosol Science Areas. ASHLEY R. RAVNHOLDT, *University of Nebraska Medical Center*

As a graduate student planning to graduate in 2025, I am seeking opportunities that blend fieldwork, research, and collaborative interaction. My research in the Infectious Aerosol Research Laboratory has provided me with a comprehensive understanding of infectious aerosol science. I have contributed to developing methods for collecting, processing, and detecting bioaerosols in medical, industrial, and school environments and have experience working with multidisciplinary teams (e.g., healthcare and school workers).

As a Ph.D. student in the Biodefense and Health Security program, I have learned processes and methodologies needed for developing expertise in global security areas related to infectious disease defense. My dissertation project focuses on potential inadvertent exposure to aerosolized biological hazards within laboratory settings. This work has equipped me with a broad knowledge base and practical skills in sampling and characterizing pathogens, particularly for biodefense.

I thrive in environments that offer the chance to engage in hands-on fieldwork, conduct research, and collaborate with diverse teams. I am particularly interested in roles within government agencies, the private sector, and industry, where I can contribute to developing and implementing solutions to understand risk and protect public health and safety. My goal is to leverage my expertise to advance the field of bioaerosol science and play a role in defending our communities against biological threats. I am especially interested in researching infectious aerosols, focusing on pathogen transport mechanisms, characterizing properties of aerosolized pathogens, and threat assessment/response strategies. I will be open to new positions in the fall of 2025, and geographically, I am flexible in relocating depending on the opportunities presented.

4JS.5

Daniel Ackerman, Senior Scientist and PhD Student, Seeking Opportunity in Government and Biodefense Sectors. DANIEL N. ACKERMAN, *National Strategic Research Institute*

My name is Daniel Ackerman. I am a Senior Scientist at the National Strategic Research Institute (NSRI) and a PhD student at the University of Nebraska Medical Center (UNMC). I have over 15 years of hands-on biological laboratory experience and have been studying bioaerosols for the past 4 years. I have provided wide-ranging technical expertise in biological assays along with sampling for infectious bioaerosols that have led me to developing methods for bioaerosol detection. I have worked with Tier 1 Select agents in both lab and field environments such as my time spent in Liberia during the 2014 Ebola Outbreak and have operated in all biosafety levels (BSL-1, 2, 3, and 4). I have supported missions that cover a broad spectrum of topics within the biodefense realm including hazard mitigation, counter-proliferation, sample collection, and detection. Currently, my studies have been focused on the advancement of bioaerosol detection and characterization. These studies encompass circular intensity differential scattering (CIDS) analysis of bioaerosols and investigating the methods to further the study of bioaerosol viability, specifically viruses. I have experience working in various methodologies to include molecular biology, microbiology, virology, cell culture, immunology, and aerosol biology. I wish to continue furthering my expertise in these disciplines and am looking for a position where I can generate ideas and have them come to fruition. My anticipated availability is dependent on my graduation date set for the end of summer semester 2025. Job positions of interest would be in the government or academia. Geographically, I would prefer to be located either in the Rocky Mountain States or the DC/Maryland/Virginia area, but I am flexible depending on the opportunities presented. I aim to make an impact in the aerosol community and hope to develop a novel tool to aid the mitigation of infectious bioaerosols.

4JS.6

Sukriti Kapur, Ph.D. Candidate at UC Irvine, Seeking Government / Industry /National Lab Positions. SUKRITI KAPUR, *University of California, Irvine*

I am a PhD candidate in the Shiraiwa Lab at UC Irvine. My research focuses on studying health effects of particulate matter from biomass burning and non-exhaust emissions.

As part of the 6-week Alaskan Layered Pollution and Chemical Analysis (ALPACA) campaign in Fairbanks, Alaska, I led efforts to collect outdoor and indoor particulate matter samples and analyze environmentally persistent free radicals (EPFRs), reactive oxygen species (ROS) and oxidative potential (OP). In a separate collaborative project ‘beyond the tailpipe’, I led efforts to assess radical formation and oxidative potential of brakewear particles. I have successfully conducted several field campaigns under these projects and am also proficient in using specialized instruments such as the electron paramagnetic resonance, ICP-MS, Hi-Vol and MOUDI samplers.

Recognizing the direct implications of my work on public health, I have been actively translating my findings in the field and lab to address air quality issues faced in environment justice (EJ) communities in Santa Ana, California. My work involves advocacy and outreach, capacity building and community engaged air monitoring, and is funded/ supported by the NSF Climate Justice Fellowship. Through this work, I have gained invaluable skills in community-based research and wish to build upon those further in my career.

Prior to my PhD, I worked for two years as a research fellow at Jawaharlal Nehru University studying land use and urban heat islands. I completed my masters in Environmental Science from Banaras Hindu University, India, where my thesis focused on aerosol optical depth in the Indo-Gangetic Basin.

I also hold a keen interest in science communication, outreach and mentorship. Throughout my career, I have led several outreach and mentorship initiatives within and outside of UCI.

I am looking for government/industry positions that span across aerosol measurements, health effects of PM and environmental justice research, with a preference for opportunities located in California.

Anticipated availability: Summer 2025

Contact: sukritk@uci.edu

4JS.7
Elizabeth Klug, Fifth-year Ph.D. Candidate Studying Early-stage Aging of Bioaerosols, Government Sector and/or Academic Careers. ELIZABETH A. KLUG, *University of Nebraska Medical Center (UNMC)*

My name is Elizabeth Klug, I am currently a fifth-year Ph.D. candidate at the University of Nebraska Medical Center (UNMC) under the mentorship of Drs. Joshua Santarpia and St. Patrick Reid. My research journey has primarily focused on the study of infectious bioaerosols and the development of a novel bioaerosol flow-through exposure system. This system has been used in studying the short-term impact of simulated environmental conditions on bioaerosols. Furthermore, my work in high containment (BSL-3) facilities involved exposing bioaerosols to these simulated conditions, providing valuable insights into their behavior and risks in controlled environments. In addition, I have worked in various environments to sample infectious diseases, including hospital, residential, and academic settings. I have dedicated significant effort to setting up and sampling these settings to understand the risk and exposure potential associated with bioaerosols.

After the completion of my doctoral studies in Spring 2025, I aim to pursue a career in infectious bioaerosol research. I have a strong interest in securing a position within government research institutions where I can further investigate bioaerosols and their implications for public health. Nevertheless, I remain open to opportunities in academic research where I can contribute to and collaborate on pioneering studies in this domain. Geographically, I have no reservations about relocating and am willing to move to pursue the right opportunity that aligns with my professional aspirations and expertise.

With my background and experience, I am confident in my ability to contribute meaningfully to the study and management of infectious bioaerosols, whether in a government or academic setting.

4JS.8
Joscelyne Guzman - Gonzalez, PhD candidate, Postdoc Position. JOSCELYNE GUZMAN - GONZALEZ, *University of Texas at El Paso*

I am a PhD candidate in the Environmental Science and Engineering program at the University of Texas at El Paso (UTEP). My main research interests are atmospheric aerosols and air quality. Previously, I participated in a NOAA summer research experience where I tried to incorporate a new dust scheme into HYSPLIT. As a member of the Atmospheric Research Laboratory at UTEP, I utilized air monitoring stations across El Paso, Tx city and ceilometer measurements to investigate the effects of high PM10 concentrations in the planetary boundary layer. This investigation lead to the finding of a planetary boundary layer height collapse around the time of high PM10. Currently, I am utilizing a photoacoustic extinctiometer (PAX) and thermal denuder to observe the impact of black carbon shell in optical properties. My previous research experiences have allowed me to learn programing languages Python and Fortran. I will be concluding my PhD degree in December 2024. I am looking for a postdoc position that will allow me to expand my knowledge in atmospheric sciences and to make me a more well – rounder researcher. Open to relocation.

4JS.9

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 aerosol processes and secondary organic aerosol (SOA) formation. In my thesis, I performed a comprehensive analysis of: (1) the SOA formation rate under various rain intensities and processes; (2) the influence of urban location and environmental factors on in-situ SOA formation rate; and (3) the impact of sea breeze on aerosol levels and source apportionments using historical monitoring measurements of particulate matter in Houston.

In my Ph.D. study, I used an 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 hope to explore SOA chemistry using mass spectrometric techniques such as VOCUS, ToF-CIMS, and PTR-MS that span gas and particle phases. I am interested in these topics to advance scientific knowledge in the hopes of improving air quality across the globe.

My ultimate goal is to work as a professor in 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.

4JS.11

Kasey Edwards, Atmospheric Chemistry PhD Candidate, Research/Regulatory Positions. KASEY EDWARDS, *University of California, Irvine*

My name is Kasey Edwards and I am a 5th year PhD candidate in the Department of Chemistry at the University of California, Irvine under supervision by Prof. Manabu Shiraiwa. My research has included both laboratory and field studies investigating the formation of radical species from particulate matter. Using electron paramagnetic resonance (EPR) spectroscopy as well as cellular and acellular assays, we quantify the ability of the particles to generate reactive species and oxidative stress upon inhalation.

My first project focused on the influence of NO_x on the production of radical species from biogenic and anthropogenic secondary organic aerosols (SOA). I published this work as a first author paper in the Journal of Physical Chemistry A in 2022. For my second project, recently accepted by Environmental Science & Technology, I conducted research on ambient persistent free radical production in Fairbanks, Alaska during the winter-time. Currently I am investigating the influence of aging on the production of radical species from biogenic SOA, and for a separate project, I am quantifying superoxide production from cells exposed to different types of particulate matter. Outside of the lab I have participated in a mentorship program as well as managerial and inclusive excellence certificates to develop myself professionally.

Prior to graduate school I worked as a chemist research fellow at the CDC, quantifying volatile organic compounds in blood using gas chromatography-mass spectrometry. From this position I gained extensive experience with instrument maintenance that I have built upon in graduate school.

I am seeking a research position in a collaborative setting focused on analytical chemistry or environmental monitoring. My geographical preference is for positions located in California, but I am open to other opportunities within the US.

Start date: Summer/Fall 2025
Contact: kasey.cherie.23@gmail.com

4JS.12

Esther Olonimoyo, Ph.D. Candidate, University of Maryland College Park, Postdoctoral/Industry Positions. ESTHER OLONIMOYO, *University of Maryland*

I am a fourth-year doctoral candidate at University of Maryland, College Park conducting research in the Environmental Aerosol Research Lab under the guidance of Dr. Akua Asa-Awuku. In general, my research expertise is in aerosol chemistry and the impacts of pollutants on soil, water, and air environments.

Technical Qualifications:
In my Ph.D. research, I employ chemistry analytical techniques and meteorological modeling tools to bridge the gap between real-time atmospheric measurements and climate model predictions. Specifically, the chapters of my research thesis discuss HPLC-PDA method development and optimization for organic acids quantification, field sampling and measurements, and controlled biomass burning laboratory studies. My undergraduate research experience included field experiments to determine the impacts of wastewater from a power plant on the soil and water environments. I also have studied the impacts of COVID-19 facemasks on incinerated solid wastes.

Unique Skillsets:
Technical: High-Performance Liquid Chromatography – Photodiode Array Detector (HPLC-PDA), Liquid Chromatography Tandem Mass Spectrometer (LC-MS/MS), Gas Chromatography-Flame Ionization Detector (GC-FID)
Others: Data analysis, Research, Written and Spoken Communication, Project Management

Employment Interests:
I am excited to continue my passion for aerosol and environmental research. I am open to several topics but have a keen interest in biomass burning, African Air quality, and subsequent impacts on international research and policy.

I am open to postdoctoral and research scientist positions at institutions (non-academic, government, or industrial). I am also interested in Environmental consulting roles. By leveraging my technical expertise and training, I hope to offer practical solutions to global environmental sustainability issues.

4JS.14

Sabrina Westgate, PhD Candidate at Georgia Tech, Seeking Position in Science Policy/Science Communication or Related. SABRINA WESTGATE, *Georgia Institute of Technology*

Throughout my PhD, my research has focused on evaluating and providing new insights into indoor air quality, particularly in university classroom settings. In my research, I have worked with cutting edge instrumentation (including mass spectrometers like the Vocus Proton-Transfer-Reactor Mass-Spectrometer), low-cost sensors, and machine learning. Obtaining funding as a National Science Foundation Graduate Research Fellow, I had the unique opportunity to develop and personally carry out multiple projects. Leading a diverse team of 5 to 10 undergraduate and graduate students on these projects, I honed my project management, leadership, and mentorship skills. Moreover, by collaborating with both peers and university leaders, I actively engaged my school community in discussions about indoor air quality and directly advised my university's administration on room usage policies and protocols during the Covid pandemic. Influenced in part by these discussions, I am passionate about the intersection of science and policy. I hold a graduate certificate in public policy, and I worked for 6 months as a science diplomacy fellow with the Science and Innovation Network at the UK Consulate in Chicago, where I co-authored a report on US STEM workforce development policy. I will finish my PhD in Chemical Engineering this November 2024. Post-graduation I am looking to work in a people-focused position that allows me to draw upon my multifaceted background. I am open to exploring a variety of positions, including but not limited to project management, science communication, and environmental or science policy. I look forward to exploring opportunities that align with my interests and expertise.

4JS.15

Tianchang Xu, Ph.D, Student, Industry/Government Positions. TIANCHANG XU, *Georgia Institute of Technology*

I am a Ph.D. student at the Georgia Institute of Technology with experience in organic aerosol characterization and chemistry. Throughout my Ph.D. journey, I have gained extensive experience in both laboratory and field studies, focusing on the properties and impacts of aerosols from various sources.

My research projects include:

· Laboratory chamber study on organic nitrate and SOA formation: Investigating the multi-generation oxidation of biogenic VOCs to address current mechanism gaps and running basic 0-D models to better understand the oxidation processes;

· Laboratory biomass burning OA study: Investigating organic aerosol formation from wildfire and prescribed fire emissions, and analyzing the effect of dilution on SOA formation to understand their atmospheric transformations;

· Field study on urban aerosols: Participating in the NYC-METS campaign in New York City (part of NOAA's AGES+ 2024 campaign), examining the sources of organic aerosols (e.g., personal care products, cooking, biomass burning, etc.), utilizing factor analysis to differentiate and quantify the contributions from various sources.

I am proficient in operating advanced mass spectrometry instruments such as HR-ToF-AMS, FIGAERO-CIMS, and PTR-MS. I am skilled in conducting daily maintenance and repairs of FIGAERO-CIMS when needed to ensure measurement quality. Additionally, I have experience with data analysis techniques and software including MATLAB, Igor Pro, and Python, which allow me to interpret complex datasets effectively.

I anticipate graduating around spring 2025 and am seeking positions in industry or government within the U.S., with no geographical preference. While I prefer to continue my career as an experimentalist, I am open to exploring new challenges and learning new skills. My goal is to apply my expertise in aerosol chemistry to address real-world environmental issues and contribute to advancements in improving air quality and public health.

4JS.16

Molly Frauenheim, Recent PhD Graduate at UNC-Chapel Hill, Seeking Government/Industry/ National Lab Position. MOLLY FRAUENHEIM, *University of North Carolina at Chapel Hill*

I recently completed my PhD in Environmental Sciences and Engineering at the Gillings School of Public Health, UNC Chapel Hill. My research involved laboratory studies investigating the chemical characterization and fate of isoprene-derived secondary organic aerosols (SOA) in low nitric oxide environments. I have developed a unique skill set that bridges organic synthesis with analytical chemistry to understand molecular-level changes in SOA composition. Specifically, my work has led to the elucidation of formation pathways and subsequent oxidation of isoprene epoxydiol isomerization products, including 3-methylenebutane-1,2,4-triol and 3-methyltetrahydrofuran-2,4-diols.

Previously, at Colgate University, I developed a novel drop freeze assay for measuring immersion mode ice nuclei and used software tools like MATLAB and Igor to analyze trends in primary biological aerosol concentrations. This experience laid the foundation for my current research on isoprene-derived aerosols.

I am now seeking a position as a chemist or physical scientist in a government lab or industry where I can apply my expertise in atmospheric science. My career goal is to bridge science and policy, leveraging my research background to address environmental challenges and contribute to effective policy solutions. My skills in chromatography-mass spectrometry, organic synthesis, and molecular spectroscopy, along with my commitment to outreach and mentorship, position me well to advance atmospheric science and public health.

Geographic Preference: East/Northeast U.S.
Start Date: ASAP/ Fall 2024
Contact: mpfrauenheim@gmail.com

4JS.17

Oladayo Oladeji, Ph.D. Candidate in Mechanical Engineering, Seeking Research Scientist Position in Air Quality and Aerosol Science. OLADAYO OLADEJI, *Carnegie Mellon University*

I am a Ph.D. candidate in Mechanical Engineering at Carnegie Mellon University, with an anticipation graduation date of May 2025. In addition to my studies, I serve as the President of the American Association for Aerosol Research (AAAR) at Carnegie Mellon University. My research centers on the detection, spatial analysis, and source apportionment of polycyclic aromatic hydrocarbons (PAHs) and volatile organic compounds (VOCs) in urban environments, utilizing advanced mass spectrometry techniques. I am actively developing and refining methodologies for the high-resolution detection of air toxics in urban settings through mobile sampling, and I am also working on land use regression models to predict ambient air pollutant concentrations.

My contributions have been pivotal in elucidating the sources and health impacts of air pollutants in urban environments. A highlight of my work includes research conducted in response to the East Palestine, Ohio train derailment, which garnered national recognition, including the National Institute of Environmental Health Sciences Extramural Paper of the Month award.

I am pursuing a Research Scientist position in air quality and aerosol science, with a particular interest in roles that integrate field research, data analysis, and environmental policy development. My extensive experience in air quality monitoring, data science, and atmospheric particle studies positions me as a strong candidate for advancing our understanding of air pollution and its impact on public health. I am eager to contribute my expertise to interdisciplinary teams focused on developing innovative solutions for cleaner air and healthier communities.

5AC.1

Secondary Organic Aerosol is Formed by Unexpected Multiphase Brown Carbon Photochemistry during Winter. LAURA MARIE DAHLER HEINLEIN, Jonas Kuhn, Karolina Cysneiros de Carvalho, Brent Williams, Jochen Stutz, Cort Anastasio, *University of California, Davis*

Subarctic cities notoriously experience severe multi-day winter pollution episodes with $PM_{2.5}$ concentrations above 35 µg/m^3, the EPA's 24-hour standard. Biomass burning (BB) for residential heating is a major source of primary organic aerosol in winter, making particles rich in brown carbon and therefore potential sites for multiphase photochemistry. Despite limited sunlight, we found that brown carbon particles in winter pollution episodes in Fairbanks, Alaska produced significant concentrations of photooxidants, such as organic triplet excited states. These particle photooxidants can react with semi-volatile BB phenols, emitted abundantly in wood smoke, to produce BB secondary organic aerosol (BBSOA) in the particles. Here, using measurements made in the winter of 2021 in Fairbanks during the ALPACA field campaign, we used the PACT-1D model to predict gas and particle BBSOA formation. We find rapid daytime BBSOA formation during pollution events driven by multiphase reactions of triplet excited states with phenols, with slow nighttime BBSOA formation when photochemistry ceases. BBSOA formation is also slow during clean periods, when our model predicts lower phenol and photooxidant concentrations. We compare our modeled phenol concentrations to field measurements of gas and particulate phenols, exploring how multiphase chemistry alters their atmospheric lifetime, and assessing how our model captures complex gas-particle partitioning in cold conditions. Finally, we compare our modeled BBSOA formation to measurements of oxidized organic aerosol to explore whether BBSOA formation can explain the observed oxidative aging of BB organic aerosol in Fairbanks. BBSOA formation can increase the amount of PM pollution, as well as alter the chemical composition, volatility, and viscosity of PM pollution; understanding the impact of unexpected winter BBSOA formation is essential for accurately modeling PM during pollution episodes in cold climates.

5AC.2

Chemical Composition and Mixing State of Wintertime Aerosol from the European Arctic Site of Ny-Ålesund. ZHENLI LAI, Zezhen Cheng, Nurun Nahar Lata, Mauro Mazzola, Stefania Gilardoni, Swarup China, *Pacific Northwest National Laboratory*

The Arctic is experiencing unprecedented transformations due to global climate shifts. With climate change accelerating at an alarming pace in this region, the interplay between aerosols and its distinctive environmental conditions holds significant consequences for both regional and global climate systems. However, direct observations of the chemical composition of individual Arctic aerosols are scarce. This study addresses this gap by offering a comprehensive characterization of aerosol particles collected at Gruvebadet site in the European Arctic during the winter months of November to December in 2020. Employing a hybrid methodology combining k-means clustering and rule-based classification, we analyzed a total of 33,448 particles and identified six distinct particle classes based on size-resolved chemical composition data obtained through micro-spectroscopy analysis. Sea spray aerosols (SSA) emerged as the dominant class in 8 out of 9 samples, comprising 81.5% of the total aerosol population. Following closely were carbonaceous particles (16.6%), with their sources likely attributed to long-range transport. Dust particles, primarily composed of aluminosilicates, were present in all samples, often mixing with SSA in varying mixing states, accounting for 5.23% of total particle population. The prevalence of SSA/dust mixtures underscores their importance as sources of cloud condensation nuclei and ice nuclei in the Arctic atmosphere. Furthermore, we examined the relative contributions of local emissions and long-range transport to Arctic aerosol composition and size distribution through case studies of different transport pattern. Moreover, it has been observed that the aging mechanism of sea spray aerosols (SSA) is significantly influenced by cloud processing during long-range transport. Aged SSA particles exhibit an enrichment in sulfur content when their air-mass history indicates potential cloud processing. This study offers new insights into the complex mixing states and compositions of diverse high arctic aerosol particles observed at a regional scale during the Arctic winter of 2020. Our findings illuminate the intricate composition and mixing states of aerosol particles, with implications for understanding potential dominant sources of ice nucleating particles (INP) in the Arctic region during winter.

5AC.3

Aerosol-Fog Interactions and Chemical Processing: Insights from the Grand Banks and Sable Island Regions during FATIMA 2022.

TREVOR VANDENBOER, Leyla Salehpoor, Leigh Crilley, Cora Young, Gianina Giacosa, Phillipe Gauvin-Bourdon, Rachel Chang, Ed Creegan, Harindra J Fernando, *York University*

Fog formation results from radiative, thermodynamic, microphysical, dynamical, chemical, surface conditions, and meteorological interactions. Aerosols can promote fog formation as condensation nuclei when the relative humidity (RH) exceeds 100%. There is an intricate relationship between aerosol and fog characteristics; physico-chemical characteristics of aerosol change by the occurrence of fog, and aerosol properties directly impact the life cycle of a fog layer. Sea fog study is critical in understanding fog formation, development, and dissipation to enable accurate forecasting and improve safe marine activities and transportation. During the Fog and Turbulence Interactions in the Marine Atmosphere (FATIMA) project, we explored the initiation and persistence of marine fog events.

We measured the chemical composition of aerosols during fog episodes and in the absence of fog to better understand how aerosol and aerosol chemistry affects (and are affected by) fog formation. Size-resolved aerosol samples were collected with two Micro Orifice Uniform Deposit Impactors on the Atlantic Condor research vessel in the northwest Atlantic Ocean from 3 July to 1 August 2022. Major water-soluble cations and anions, $DEAH^+$, $TMAH^+$ (diethylamine, trimethylamine), and MSA^- (methane sulfonic acid) were quantified by ion chromatography with conductivity detection. Coarse mode ions Na^+ and Cl^- dominated under both conditions, as expected for sea salt. In some fog events, sea salt loadings increased before fog formation and then decreased or were entirely lost. This suggests that NaCl aerosols may act as initial fog condensation nuclei but do not sustain the fog droplet number. Fine mode NH_4^+ and nss-SO_4^{2-} were the most abundant inorganics in both fog and non-fog aerosols. An increased sum of total concentration (neq m^{-3}) of NH_4^+, $DEAH^+$, $TMAH^+$, MSA^-, and nss-SO_4^{2-} was observed in fine mode aerosols during the fog periods suggesting uptake of gaseous precursors was facilitated. We show that fog water and coarse aerosol pH differ, and that interstitial aerosol pH increases during fog events as a result.

5AC.4

Seasonal Assessment of Secondary Organic Aerosol Formed through Aqueous Pathways in the Eastern United States.

Ahsan Ali, Christopher Hennigan, Havala Pye, Benjamin Murphy, Prashant Shekhar, MARWA EL-SAYED, *Embry-Riddle Aeronautical University*

The uptake of water-soluble organic gases ($WSOC_g$) formed from the oxidation of VOCs into atmospheric aerosol liquid water is an important pathway for the formation of aqueous secondary organic aerosol (aqSOA). Despite its significance, numerous uncertainties persist in our understanding of aqSOA formation, including the contribution of aqSOA mass to total SOA across seasons and the relative split between reversible and irreversible aqSOA mass. In this study, we use seasonal WSOC measurements in the particle and gaseous phases (i.e., $WSOC_p$ and $WSOC_g$, respectively) in Baltimore, Maryland to quantify the total aqSOA as well as the reversible and irreversible aqSOA across seasons. Total aqSOA mass is determined using a polynomial differentiation method based on the increase in the partitioning coefficient, [$F_p = WSOC_p/(WSOC_g+WSOC_p)$], as a function of relative humidity (RH). Reversible aqSOA concentrations are calculated based on the difference between the ambient and dried $WSOC_p$ measurements. On the other hand, the irreversible aqSOA is estimated based on the dry partitioning coefficient, [$F_p' = WSOC_{p,dry}/(WSOC_g+WSOC_{p,dry})$], and RH. Further, comparisons between the seasonally measured aqSOA concentrations and their counterpart Community Multiscale Air Quality Modeling System (CMAQ) modeled mass are conducted. In addition to improving our understanding of aerosol multiphase formation, this work holds several implications for atmospheric chemistry and modeling aiming to bridge the current gap between model predictions and field measurements.

5AC.5

Assessing Atmospheric Aerosol Transport and Transformation in Central Europe: Insights from Project Trace. SHUBHI ARORA, Laurent Poulain, Radek Lhotka, Jakub Ondráček, Petra Pokorná, Petr Vodicka, Jaroslav Schwarz, Vladimír Ždímal, Hartmut Herrmann, *Leibniz Institute of Tropospheric Research*

The trend in PM10 concentrations in Europe has stagnated over the last two decades, despite ongoing reductions in PM emissions, possibly due to the aging processes of atmospheric particles and their long-range transport. Project TRACE aims to assess these factors in Central Europe, focusing on anthropogenic sources such as coal and wood combustion. Using synergic online (Aerosol Mass Spectrometer and Aethalometer) and offline (GC-MS and Ion Chromatography) methods, the project evaluated the transport and transformation of atmospheric aerosols. In 2021, measurements were conducted at three sites (Melpitz, DE; Kosetice, CZ; and Frydlant, CZ) during winter (February 1st – March 10th) and summer (July 1st – August 20th). During winter, inorganic species (nitrate and sulfate) dominated aerosol particles at all sites, while organics became dominant in summer. At Melpitz, winter nitrate and sulfate concentrations were higher (24 $\mu g/m^3$ and 9 $\mu g/m^3$ respectively) compared to summer (9 $\mu g/m^3$ and 5 $\mu g/m^3$). Significant seasonal differences were observed not only in mass concentrations but also in the babs coefficient for brown carbon absorption and its relative contribution to total absorption at 370 nm. Winter brown carbon absorption coefficients varied across stations: 11.87 Mm^{-1} for Frydlant, 9.07 Mm^{-1} for Melpitz, and 8.77 Mm^{-1} for Kosetice, with a coefficient of variation of 14.09%. This could be an indication to the distinct character of the type and source of brown carbon at Frydlant which according to our study is purportedly darker (more absorbing) than that observed at Kosetice, albeit its low contribution. Meteorological conditions and back air mass trajectories (96 hrs, 500 m above ground altitude) based on the NOAA-HYSPLIT model were also used to identify potential connections between sites and the geographical origin of emissions.

5AC.6

Advancing Aerosol Chemical Characterization and Vertical Profiling Over the Southern Great Plains via Integrated Uncrewed Aerial Sampling and Aerosol Mass Spectrometry Analyses. CHRISTOPHER NIEDEK, Fan Mei, Wenqing Jiang, Justin Trousdell, Maria Zawadowicz, Beat Schmid, Qi Zhang, *University of California, Davis*

Uncrewed aerial systems (UAS) help fill gaps in atmospheric observations that exist between traditional, crewed aircraft and ground-based measurement campaigns. Recent advances in UAS technology, particulate matter (PM) sampling, and offline analytical techniques have greatly expanded the potential of UAS to complement other PM measurement modalities. This study utilizes UAS and ground-based instrumentation to examine PM chemistry aloft (e.g. within the boundary layer) versus at ground level and across seasons at the Southern Great Plains atmospheric observatory (SGP). UAS meteorological and PM chemical data reveal key differences in PM characteristics across seasons, reflecting seasonally different emission sources and atmospheric transformation processes. For example, nitrogen-containing organic PM, noted in prior studies examining aerosols at SGP, are similar in winter and early summer but exhibit a clear change in source during late summer. Additionally, comparisons between UAS PM data and ground-based aerosol chemical speciation monitor (ACSM) data underscore the importance of sampling altitude and planetary boundary layer height when examining PM chemistry. In winter, when UAS sampling altitudes were largely above the boundary layer, PM collected by UAS have significantly higher contributions from organic aerosols compared to concurrent ACSM measurements, where inorganic species (e.g. nitrate, sulfate) constitute a greater proportion of total PM mass. Furthermore, UAS samples collected entirely above the boundary layer are also significantly more oxidized than those collected partially within the boundary layer, even during the same months. This work highlights the utility of UAS to complement established PM measurement techniques and to investigate vertical differences in PM chemistry that can be difficult to capture using other methods.

5AC.7

Real-time Detection of Gaseous Chlorinated Paraffins at Multiple Field Sites with Chemical Ionization Mass Spectrometry.

DANIEL KATZ, Bri Dobson, Harald Stark, Manjula Canagaratna, Mitchell Alton, Douglas Worsnop, Eleanor Browne, *University of Colorado Boulder & CIRES*

Chlorinated paraffins (CPs) are polychlorinated alkyl compounds which are considered persistent organic pollutants due to their toxicity to humans and wildlife, long lifetimes, and ubiquity in the environment. CPs are synthetic compounds with a wide range of industrial applications and are typically produced as a mixture of compounds with a range of carbon numbers and degrees of chlorination. CPs are released to the environment throughout their production, use, and disposal lifecycle. While much of the scientific investigation of CPs has focused on short chain chlorinated paraffins (SCCPs), measurements of medium chain chlorinated paraffins (MCCPs) are scarce. Increased regulation of SCCPs, including under the Stockholm Convention, is expected to precipitate an increase in the production of MCCPs as replacements for SCCPs. As MCCPs account for a larger portion of CP production, understanding the cycling and fates of MCCPs in the environment will be increasingly important. Measurements of atmospheric CPs have typically relied on polyurethane foam samplers which require long sample collection times and obscure the temporal behavior of CPs in the ambient air. Here, we present the first real-time detection of gas-phase CPs using nitrate ion chemical ionization mass spectrometry (NO3-CIMS). The detected CPs have a range of carbon and chlorine atoms in their formulas. Due to the number of carbon atoms in the detected CPs, we classify them as MCCPs. Ambient measurements from multiple disparate field sites will be presented. We show that the diel behavior of MCCPs is explained in part by partitioning of MCCPs between the particle phase and gas phase. The presence of MCCPs in the particle phase suggests they may be transported over long distances in the atmosphere. The predicted particle fractions of the detected compounds vary with alkyl chain length and degree of chlorination, which impacts the lifetimes and fates of different MCCP compounds.

5AP.1

The Drying Kinetics and Crystallization of Liquid-Liquid Phase Separated Aerosol.

BARNABY MILES, Lukesh Mahato, Rachael E.H. Miles, Jonathan P. Reid, *University of Bristol*

Liquid-liquid phase separation (LLPS) is a process that can occur in aerosol droplets containing a mixture of organic and inorganic components below a given relative humidity. This phase separation can lead to changes in the aerosol droplets physiochemical properties, such as its ability to act as a CCN seed, the heterogeneous reactivity and it’s optical properties. There has been previous work looking at LLPS for a number of different systems, with investigations into the RH at which LLPS occurs and the mechanism that causes the separation e.g. spinodal decomposition or nucleation and growth (D. Stewart et al. (2015), S. Ma et al. (2021), J. Choczynski (2024)). There has not yet been any investigations into the effects of RH and droplet composition on the physiochemical properties of the resultant ‘dried’ particles for aerosols that undergo LLPS.

Here, we present novel investigations into the impact of RH, organic: inorganic (O:I) component ratio, and organic component chain length, on the evaporation and crystallization processes of aerosol droplets that undergo LLPS. Droplet evaporation profiles and phase functions were measured using an Electrodynamic balance (EDB) and compared to a model implementation for coupled heat and mass transport from solution droplets (SADKAT) (Robinson and Hardy (2022)). 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 the effect of evaporation rate on the phase separation behavior (e.g. the time taken for the droplets to undergo LLPS, and the radius of the droplet when LLPS occurs). We further present details of the relationship between O:I ratio, organic component chain length, phase separation behavior, crystallization behavior and resultant particle morphology.

5AP.2

The Role of Supersaturation in Tropical Atlantic Marine Boundary Layer Aerosol-cloud Observations. JERAMY DEDRICK, Christian Pelayo, Lynn M. Russell, Dan Lubin, Mark Miller, Johannes Mülmenstädt, *Scripps Institution of Oceanography*

Low-level cloud microphysical properties are very sensitive to changes in the properties of aerosol, particularly in clean marine regions where small relative number concentration changes are amplified in low baseline conditions. In this work, we evaluated the Twomey effect using aerosol, cloud, and radiative observations below low-level marine clouds on a remote tropical South Atlantic island during the DOE ARM Layered Atlantic Smoke Interactions with Clouds (LASIC) campaign. Measured aerosol size distributions were fit with three modes representing Aitken, accumulation, and sea spray aerosol and combined with submicron composition to estimate hygroscopicity. To investigate cloud supersaturation (S), we retrieved the Hoppel minimum diameter from modal fits and hygroscopicity estimated from submicron composition. Accumulation-mode aerosol contributed 75% of the cloud condensation nuclei (CCN) number at $S<0.3\%$. Three ensemble-based and two parcel-based approaches were employed to further estimate S using measured aerosol and droplet concentrations and local cloud base updrafts across clean and smoky conditions. S agreed well with a parameterization constrained by the observed accumulation-mode aerosol and updraft, but not for the quasi-steady state approximation. Increases in accumulation-mode number increased cloud drop number, showing the activation response to aerosol, and reduced supersaturation most strongly at low updraft, illustrating the supersaturation response to aerosol. Droplet size sensitivities to aerosol number were included in a modified decomposition of the cloud albedo susceptibility into Twomey and meteorological components. These results show a strong sensitivity of the LASIC cloud baseline to aerosol perturbations.

5AP.3

Impact of Phase State on the Competition between Condensation and Coagulation. KIEUDIEM NGUYEN, Meredith Schervish, Manabu Shiraiwa, *University of California, Irvine*

Particle size distribution is a critical property for radiative forcing and cloud activation of atmospheric aerosol particles. The evolution of particle size distribution is influenced by condensation and coagulation. While condensation drives the growth of secondary organic aerosols (SOA), coagulation leads to scavenging of small particles to reduce particle number concentrations. It has been shown that amorphous semisolid and glassy solid phase states in SOA can cause kinetic limitations for condensational growth, but their influence on competition between condensation and coagulation has not been evaluated. In this work, we implement coagulation into the kinetic multilayer model of gas-particle interactions (KM-GAP) to simulate evolution of particle size distribution by condensation and coagulation for particles with different phase states. Equilibration timescales of SOA partitioning (τ_{eq}) and coagulation timescales (τ_{coag}) are calculated for liquid, semisolid, and solid particles with different volatilities of organic compounds for closed and open systems. Our results show that condensation of semi- and low-volatile species mostly leads to the narrowing of particle size distribution, while when coagulation is dominant a reduction in the number of particles with a broader size distribution is observed. Our results also show that τ_{eq} is shorter for condensation of lower volatility compounds into viscous particles in a closed system as rapid equilibrium is established between the gas phase and the particle surface. τ_{eq} prolongs to hours and days for condensation of semivolatile compounds into semisolid and solid particles ($D_b \leq 10^{-15}$ cm^{2}s^{-1}), which makes coagulation as a competitive process. We also illustrate that coagulation should be mostly insignificant for chamber experiments for SOA formation in the presence of seed particles, while coagulation becomes important for nucleation events and for biomass burning plumes with high particle concentrations.

5AP.4

Influence of Non-polar Amino Acids on Phase Transitions of Aerosol Particles. KIRAN REDDY PITTA, Miriam Freedman, *The Pennsylvania State University*

Phase transitions in atmospheric aerosol particles have a significant impact on heterogeneous chemistry, hygroscopicity, and cloud formation. The composition of the particles influences aerosol phase transitions. A large fraction of particles contain both organic and inorganic compounds, with organic matter constituting 20 to 90% of the particle mass. Organonitrogen compounds are estimated to compose up to 30% of the total organic fraction. Despite this significant presence, the phase transition properties of aerosol particles involving organonitrogen species have not been thoroughly researched. Amino acids, a type of organonitrogen compound found in the atmosphere, were chosen for the study. Non-polar amino acids were used, where the amino acids were mixed with either 2-methylglutaric acid or 1,2,6-hexanetriol (model oxidized organic compounds) and ammonium sulfate (inorganic salt) to study the effect of the concentration of amino acids on the phase transition properties of droplets using an optical microscope. A suppression of separation relative humidity was observed with an increase in the concentration of amino acids, while an increase in efflorescence relative humidity was observed in the case of relatively low solubility amino acids (leucine, isoleucine, and valine). A three-phase morphology was detected for some systems, with the efflorescence of amino acids competing with the phase separation of the 2-methylglutaric acid/ammonium sulfate and 1,2,6-hexanetriol acid/ammonium sulfate systems. These studies are important in understanding the impact of organic-organic interactions on the phase transition properties of aerosol particles, which have consequences for heterogeneous chemistry in the atmosphere.

5AP.5

Simulating Diffusion-driven Phase Separation in Atmospheric Aerosols. ANDREAS ZUEND, Zixuan Shen, Ying Li, Meredith Schervish, Manabu Shiraiwa, *McGill University*

Airborne particles consisting of organic and inorganic species have been shown to frequently exhibit phase separation. Liquid–liquid phase separation (LLPS) has impacts on size-dependent particle morphology, hygroscopicity, heterogeneous reactions, and phase viscosities. In this presentation, we will introduce a new approach for simulating the time-resolved, diffusion-driven liquid–liquid phase separation and/or phase merging in particles of various sizes exposed to changing environmental conditions. Traditionally, the prediction of liquid–liquid phase separation in bulk aerosol systems can be conducted using a thermodynamic equilibrium framework, such as a liquid–liquid equilibrium model based on Aerosol Inorganic–Organic Mixtures Functional groups Activity Coefficients (AIOMFAC). However, in the context of the nonequilibrium evolution of particles that either start in a phase-separated core–shell configuration or adopt one over time, e.g., due to evaporation of water, phases of distinct chemical compositions and viscosities may emerge or disappear, affecting nonideal mixing, growth kinetics, and equilibration times. This is of particular interest in viscous, semi-solid particles that evolve slowly under typical indoor or outdoor conditions. Furthermore, understanding a potentially size-dependent evolution of LLPS and bulk–surface partitioning (e.g. comparing ultrafine vs. fine mode particles) is of interest in practice due to associated effects on cloud droplet activation and heterogeneous chemistry – aspects that are not represented in current large-scale atmospheric models. Our simulations make use of the recently developed ONION box model. ONION is a multicomponent, multilayer kinetic model based on a combination of the kinetic multilayer gas–aerosol partitioning (KM-GAP) framework and the AIOMFAC model for chemical thermodynamics. By introducing a composition-dependent model for interfacial energy contributions between distinct model phases (and layers), we can model dynamic phase separation of the core–shell type with ONION. We will discuss simulations of spinodal decomposition LLPS under humidification or drying conditions, providing insights into dynamic aerosol growth.

5AP.6

Time-Resolved Picoliter Droplet Surface Tensions over Microsecond to Millisecond Timescales. M. ISABEL QUANT, Alison Bain, Jim Walker, Bryan R. Bzdek, *University of Bristol*

Atmospheric surfactants are an important class of surface-active compounds that can originate from natural sources like sea-spray. Surfactants can lower the surface tensions of aerosol droplets, potentially influencing the fraction of atmospheric aerosol that activates to cloud droplets. Moreover, because of their high surface area-to-volume ratios, chemical reactions in microcompartments like aerosol droplets become more sensitive to partitioning equilibria at the interface. Resolving how surfactants partition to the droplet-air interface is essential both to understand cloud droplet activation and to explain observations of highly accelerated chemical reactions in microcompartments.

The dynamic surface tensions of microscopic droplets can be explored through stroboscopic imaging of a stream of monodisperse droplets. Ejected droplets undergo characteristic time-dependent shape oscillations, the frequency of which permits retrieval of droplet surface tension as a function of surface age. Although initial studies permit exploration of dynamic surface tensions over several hundred microseconds after droplet generation, such timescales are insufficient to fully characterize surfactant partitioning to the droplet surface, which can take >1 ms. By coalescing two droplets, surface oscillations can be re-excited, allowing access to even longer droplet ages (~500 – 1000 µs after droplet generation).

This contribution describes the results of experiments designed to characterise the dynamic surface tensions of droplets out to 1 ms surface age. Two microdroplet dispensers were positioned such that the droplets they generate coalesce in a controlled manner, with the coalescence and resulting shape oscillations visualised through stroboscopic imaging. Droplets whose surface tensions span a wide range (e.g. containing water, ethanol, or organic acids) were investigated, with retrieved surface tensions agreeing with expectations. Results from extending the approach to surfactant systems will be discussed, along with comparisons to measurements made on single droplets accessing shorter surface ages.

5AP.7

Photochemical Aging Enhances the Viscosity of Biomass Burning Organic Aerosol. NEALAN GERREBOS, Sepehr Nikkho, Lyle Browning, Julia Zaks, Changda Wu, Allan K. Bertram, *University of British Columbia*

Biomass burning organic aerosols (BBOA) are a major contributor to organic aerosols in the atmosphere. Viscosity is an important property of BBOA, as it influences many of the processes it is involved in in the atmosphere; this includes but is not limited to particle growth rates, heterogeneous reactivity, and photochemistry. As BBOA is transported through the troposphere, it undergoes photochemical aging due to reactions with atmospheric oxidants such as OH and O_3. Recently it has been shown that the viscosities of some aerosols can be enhanced through atmospheric aging processes. However, research on the influence of atmospheric aging on BBOA is still limited.

We used a Potential Aerosol Mass oxidative flow reactor (185 nm mode) to expose BBOA to high concentrations of OH and O_3, simulating the equivalent of 1 to 8 days in the troposphere. We measured the viscosity of the photochemically aged BBOA with the poke-flow viscometry technique, and found that aging increased the viscosity of BBOA. After 1 day of aging, the viscosity of BBOA increased by several orders of magnitude. However, further aging up to 8 days saw a less dramatic increase in viscosity, with no noticeable increase between 5 days and 8 days. We also measured the carbon oxidation state of the BBOA with high-resolution aerosol mass spectrometry, and the trend in increasing oxidation state reflected the trend in viscosity. This suggests that the most dramatic changes in the physicochemical properties of BBOA occur within the first days or hours of aging, after which oxidation becomes a less significant aging mechanism. These results have implications for how the physicochemical properties of BBOA should be treated in models.

5BA.1

Airborne Influenza Virus Monitoring in an Elementary School Using the Growth-based Virus Aerosol Concentrator with Paper-based Sensors. CHANHWI PARK, Junbeom Jang, Jaesung Jang, *Ulsan National Institute of Science and Technology, Korea*

Monitoring of viruses in indoor air is crucial for preventing the spread of respiratory diseases. In particular, influenza viruses exhibit a high infection rate among children, and the communal living environment in schools serves as a significant risk factor for group transmission. However, technology for rapid monitoring of airborne viruses faces several challenges, and researches on airborne viruses within elementary schools is currently very limited.

In this study, we present an airborne influenza virus monitoring system that integrates the water condensation growth-based virus aerosol concentrator (GVC) with paper-based immunosensors for on-site airborne influenza virus surveillance. In a laboratory, the GVC concentrated airborne viruses to detectable levels (more than 350 copies/mL) within 10 min at 6 Liters/min (LPM), and the concentrated viruses could be measured within 30 min using paper-based sensors. These paper-based sensors were designed to measure two viral proteins, surface protein hemagglutinin (HA) and internal protein nucleoprotein (NP), enabling the assessment of the degree of surface damage to virus particles. The limit of detection (LOD) of the sensors were 42 PFU/mL for HA and 62 PFU/mL for NP within a range of 10^1 to 10^6 PFU/mL. Furthermore, we conducted air sampling and sensor measurements for various locations within an elementary school near UNIST, including classrooms, cafeteria, and corridors, using the measurement system over 8 working days, collecting a total of 17 samples at a flow rate of 6 LPM for one hour each. The results confirmed influenza-positive in five samples with concentrations ranging from 10^1 to 10^5 PFU/mL. These results were compared with those obtained using the commonly used SKC BioSampler and gelatin filters, demonstrating that the currently proposed system has the strong potential for real-time, on-site, and continuous indoor airborne pathogen monitoring in various fields.

5BA.2

Ultra-sensitive Capacitive Biosensor for Multiplex Viruses Detection to Prevent Zoonotic Outbreaks. JOSHIN KUMAR, Max Xu, Yuezhi (August) Li, Shu-Wen You, Joseph V. Puthussery, Rajan K. Chakrabarty, *Washington University in St. Louis*

Recent outbreaks of respiratory viruses have underscored the need for sensitive, rapid, and specific diagnostic methods for viruses, particularly those capable of animal to human (zoonotic) transmission. In this study, we introduce a rapid label-free capacitive biosensor based on the excellent dielectric property of Prussian Blue (PB) deposited on Screen Printed Carbon Electrodes (SPCEs) to provide ultra-sensitive detection of viruses with multiplex potential in the practical application.

The strategy involves the immobilization of target-specific antibodies on SPCEs, followed by the electrodeposition of PB. The surface dielectric layer capacitance (Cdl) was analyzed using electrochemical impedance spectroscopy (EIS), and the normalized changes of Cdl were owed to the capture of target viruses. The normalized ΔCdl showed a linear correlation with the concentration range from 25 viral copies/ml to 1000 copies/ml for both SARS-CoV-2 and H1N1 in the PBS. Furthermore, the platform was tested with swab samples from animal processing facility spiked with viruses, and provided specific detection only to the target of interest with very low interference from other existed contaminants.

This novel approach with competitive sensitivity, selectivity, and a potential for multiplexed detection promises significant advancement in the early prevention of diseases transmission, enhancing our ability to combat zoonotic outbreaks.

5BA.3

Cultivation and Propagation of Viable Viral Aerosols for Upstream Amplification and Infectivity Analysis.

DANIEL N. ACKERMAN, Ashley R. Ravnholdt, Joshua L. Santarpia, *University of Nebraska Medical Center*

Viral aerosols have recently garnered significant attention due to the COVID-19 pandemic. This has led to a call for more advanced environmental sampling for infectious aerosols. Currently, collected aerosol samples are typically analyzed for the presence of viral pathogens with detection platforms such as PCR. However, these detection platforms are constrained by their limit of detection and do not provide answers to the infectious nature of the virus. Laboratory culturing of samples have provided some answers to viral viability, though can prove to be difficult due to time and transportation. In our study, we explore the feasibility of integrating a viral propagation phase into an aerosol sampling system. By enriching a portion of the sample with the target host, we aim to provide the viral pathogen of interest an opportunity to multiply. This can potentially lead to an amplification of viral content for enhanced detection sensitivity. Consequently, an increase in target signal compared to pre-propagation will inherently suggest the presence of viable virus thus demonstrating the infectious state of the aerosol. The system holds promise for improving our understanding of viral aerosol viability and infectivity, which is crucial for the development of strategies to mitigate airborne transmission of pathogens.

5BA.4

Using Viral Aerosol Fluorescence to Aid Interpretations of Virus Inactivation: Application of Wideband Integrated Bioaerosol Sensor (WIBS).

ZHENYU MA, Herek L. Clack, *University of Michigan*

Introduction: Pathogenic bioaerosols, such as bacteria or virus particles, play an important role in affecting human health. To analyze these bioaerosols, fluorescence methods offer a high degree of specificity in target compound detection and analysis of certain fluorescent organic compounds. In this study, a wideband integrated bioaerosol sensor (WIBS) is used to analyze the fluorescence intensity of aerosolized viruses. After exposure to non-thermal plasma (NTP), producing conditions known to create reactive oxygen and nitrogen species and induce rapid virus inactivation, a decrease in the fluorescence of MS2 bacteriophage aerosol is observed. Simultaneous sampling has demonstrated the relationship between the decrease in aerosol fluorescence signal and the decrease of aerosolized virus infectivity.

Methods: The experimental setup consists of: a nebulizer (Mesh Nebulizer YM-3R9) that generates bacteriophage MS2 aerosols at 1 mL/min, a WIBS to detect changes in aerosol fluorescence, and a dielectric barrier discharge NTP reactor to inactivate aerosolized viruses. Bioaerosol fluorescence detection is performed by WIBS, manufactured by Droplet Measurement Technologies. In operation, WIBS is connected to sampling ports on the NTP reactor and samples aerosolized viruses before and after momentary plasma exposure. Aerosol fluorescence intensity at 310-400 nm is recorded for all particles during a 1-min sampling period after excitation at 280 nm. The NTP reactor generates plasma using an AC power supply (20 kV, 350 Hz) with an airflow rate through the reactor of 120 lpm. Upon collection of MS2 aerosol into impingers at both the inlet and outlet of NTP, samples are analyzed via plaque assay to quantify the infectious virus concentration. A plasma-power-off control is also performed to address any potential effect on infectivity assay and WIBS fluorescence measurements from the system.

Results: Aerosol fluorescence intensity at 310-400 nm, measured on a single-particle basis, is then plotted against the relative abundance of such particles to construct a ‘fluorescence distribution curve’. Results show that MS2 has a fluorescence distribution curve significantly distinct from the background, which measures the background particle fluorescence regardless of the detection of in-flow particles by WIBS. Its fluorescence decreases after exposure to NTP, whereas it remains constant when it passes through the powered-off NTP reactor. In addition to the fluorescence change, NTP exposure also led to a 1.05-log PFU/mL inactivation of MS2 aerosols, verified by plaque assay. Besides, by adjusting the plasma power, it is observed that the level of change of fluorescence signal also has a relationship with the inactivation level of MS2 aerosols.

Conclusions: The measured fluorescence of MS2 aerosols are found to correlate with their infectivity level. WIBS has the potential to provide information on fluorescent organics on the outer surface of bioaerosols, which would be helpful in understanding the virus inactivation process.

5BA.5

Understanding the Impact of Relative Humidity, Ozone, and Simulated Sunlight on Early Stage Aging of Infectious Bioaerosols.

ELIZABETH A. KLUG, Danielle N. Rivera, Daniel N. Ackerman, Ashley R. Ravnholdt, Kevin K. Crown, Gabriel A. Lucero, Ningjin Xu, Don Collins, Joshua L. Santarpia, *University of Nebraska Medical Center (UNMC)*

Viral diseases that are transmitted as aerosols pose a significant risk to the public. This was especially evident during the COVID-19 pandemic. 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 aerosols properties in response to environmental conditions. Many of these studies have been accomplished using the well-known aging system, the Goldberg rotating drum. However, use of the rotating drum comes with significant drawbacks such as a failure to capture the loss of initial pathogen infectivity and a small sample volume. The Biological Aerosol Reaction Chamber (Bio-ARC) is an alternative approach that uses a flow-through system to rapidly expose large numbers of biological particles to controlled environmental conditions and determine the sensitivity and mechanisms of aging through analysis of the collected samples. Using this system, we investigated the stability of two viruses that represent two distinct types of aerosol transmission and may differ in how they respond to environmental insult: Sin Nombre Virus (SNV) and SARS-CoV-2. Both pathogens are enveloped and consist of similar protein structures. The major difference is the mode of transmission. SNV transmission occurs through the inhalation of mouse excreta in the environment and SARS-CoV-2 transmission occurs though inhalation of infectious respiratory fluids. Using the Bio-ARC, we report the first aerostability experiments with SNV, as well as the sensitivity of SARS-CoV-2 when exposed to ozone, simulated sunlight and elevated relative humidity.

5BA.6

Inactivation of Four Structurally Distinct Respiratory Viruses in Respiratory Droplets at Variable Relative Humidity.

NICOLE C. ROCKEY, *Duke University*

Respiratory infections from viral pathogens cause significant morbidity and mortality each year globally. These viruses transmit to susceptible hosts via numerous routes, including through inhalation or spray of aerosols or droplets emitted by a shedding individual or contact with surfaces contaminated by a shedding individual. Importantly, these transmission routes dictate that respiratory viruses are exposed to the environment in which spread occurs. Sustained virus infectivity during this environmental transport phase is critical for successful spread. Various environmental factors can affect stability during this stage of transmission, including relative humidity (RH), temperature, pH, and aerosol or droplet particle composition. Virus inactivation may result from structural damage or conformational changes to viral proteins, the lipid membrane, and/or the viral genome. Respiratory viruses exhibit a diverse range of virion structures, and these viral attributes also likely impact virus stability. However, the mechanisms driving virus inactivation in indoor spaces, which are often associated with elevated transmission rates, are not well understood; how these mechanisms may differ from virus to virus is also unclear.

Here, we address these knowledge gaps by evaluating the reduction in infectivity of four important but distinct enveloped and nonenveloped human respiratory viruses (i.e., influenza viruses, coronaviruses, rhinoviruses, adenoviruses) in saliva droplets under a range of environmental conditions (e.g., 20% to 80% RH) representative of indoor settings. In parallel, we assess viral protein damage using enzyme-linked immunosorbent assays and genome degradation using quantitative PCR covering a large percentage of each viral genome (i.e., ~50%). Our findings will provide a comprehensive dataset of the relative persistence of prominent human respiratory viruses to better understand settings conducive to environmental virus inactivation. These data are critical to informing engineering treatments targeted at specific pathogens to rapidly decrease infectious viral loads during intervals of elevated community spread.

5BA.7

Computational and Molecular Dynamics Modeling to Reduce Environmental Effects on Bioaerosols and Mitigate Disease Transmission. Meiyi Zhang, Brooke Smith, John Cate, Stephen King, Sunil Kumar, MARIA KING, *Texas A&M University*

Viral infectivity and antimicrobial resistance (AMR) of bacteria pose increasing threat to global public health, requiring effective treatment strategies. Even though antibiotics, metals, and other pollutants are the main drivers for AMR development, growing evidence suggests that other environmental stressors such as air conditioning airflow contribute to triggering resistance in aerosolized pathogens. Due to mechanical and molecular forces, deposition, resuspension, attachment, and detachment from surfaces may change the behavior of bioaerosols in ventilation airflow. Our study demonstrates that different environmental conditions affect the binding kinetics of virus proteins to different surfaces. Experimental data and modeling results show that aerosolization not only exerts mechanical stress on bacteria, but also affects their cell membrane, indicating correlation with the airflow triggering resistance mostly to antibiotics that inhibit cell wall synthesis. Although bacteria are robust creatures, environmental conditions, including airflow parameters can be manipulated to disrupt their proliferation. The layout of a facility will directly affect whether the rooms are more likely to become contaminated with aerosolized pathogens or not. Of greatest concern in food processing facilities and healthcare settings is the possibility of generating bioaerosols containing resistant pathogens. Therefore, it is critical to optimize the airflow patterns to minimize the entrainment of pathogens and the residence time of contaminated air. Computational airflow models developed in this study show that facility layout strongly affects the transport and behavior of bioaerosols, opening new avenues for engineering to reduce adverse responses triggered by environmental effects and combat their spread.

5CE.1 – INVITED

Micro- and Nanoplastic Particles from an Atmospheric Perspective. YUE ZHANG, Arthur W. H. Chan, Andrew Ault, Jonathan Slade, Sining Niu, Sahir Gagan, Zezhen Cheng, Alana Dodero, Ruizhe Liu, Qian Zhao, Qi Ying, Xingmao Ma, Swarup China, Manjula Canagaratna, *Texas A&M University*

The prevalence of the micro- and nanoplastics detected in the ecosystem is an emerging problem worldwide. Comparing with micro- and nanoplastics particles (MNPPs) in other environmental systems, atmospheric MNPPs can significantly facilitate the long range transportation of environmental plastics while contributing to climate forcing.

Despite their increasing importance, the sources, concentrations, processing, and impacts of atmospheric MNPPs are still not well understood. Herein, this presentation will first provide an overview of MNPPs, followed by how atmospheric tools can be used to address unique scientific questions that need urgent answers to improve understanding of the source, processes, and impacts of atmospheric MNPPs.

The presentation will then introduce the first study to quantify real-time nanoplastics concentrations in the atmosphere and its potential applications. A high-resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS) is employed to detect several most abundant types of submicron plastic particles. The results are validated by prolysis gas chromatopgraphy mass spectrometry (Py-GC-MS). Ambient particles are also collected and analyzed by a constrained PMF (multilinear engine, ME-2) method to determine the temporal distribution of nanoplastic particles. A distinct factor highly correlated to the pure (polystryene) PS profile is separated, with the mass concentration of PS nanoplastic particles is estimated to be 10-50 ng/m^3 during the ambient sampling period.

The presentation will then move onto the atmospheric processing of MNPP, including the aging and lifetime of PS particles through reacting with common atmospheric oxidants such as hydroxyl radicals (OH·), ozone, and UV light. The pseudo first order rate constant of PS particles against OH· radicals, k_{PS}, is quantified to be, 1.374×10^{-13} cm^3 molecule^{-1} s^{-1} while the ozonolysis and photolysis rates were negligible. Additionally, the atmospheric lifetime of MNPPs is determined to be much shorter compared with the lifetime of MNPPs in other media. The hygroscopcity of MNPPs will also be shown to creases as a function of aging, suggesting oxidized functional groups forming on the surface of the MNPPs.

To sum up, recent advancements in atmospheric MNPPs further suggest that characterizing their concentration and processes may bridge important gaps in understanding their long range transportation abilities, environmental persistence, health implications, and potential contribution to climate forcing.

5CE.2

Nanoplastic Particle Emissions from Plastic Smoldering Combustion. HONGRU SHEN, Arthur W. H. Chan, Jonathan Abbatt, *University of Toronto*

Atmospheric nanoplastic particles (NPP, <1 mm in diameter) are an emerging environmental concern due to their potential adverse effects on human health, global climate, and ecological systems. Recent field studies observed widespread atmospheric NPP presence, with plastic combustion as a potentially important source. However, the physical and chemical properties of NPP emissions from plastic combustion are unknown. Our study focused on the NPP emissions from plastic smoldering, an incomplete combustion stage lasting for a long period and posing high risks. Five types of plastics are selected, including low-density polyethene (LDPE), propylene (PP), polyethylene terephthalate (PET), polyvinyl chloride (PVC), and polystyrene (PS), and smoldered at temperatures up to 350℃ in a small combustion vessel. For all particles, a strong sub-micron mode (200-300 nm) of emitted particles was observed, along with a super-micron-sized particle mode (>20 um). We used a high-resolution time-of-flight aerosol mass spectrometer (AMS) to identify and quantify NPP emissions based on specific fragment ions, for example, C8H9+ for PS and C8H6O4+ for PET. For the NPP from all plastic types, the AMS mass fractions of m/z 60 are low (<0.01) and the ratio of m/z 55 to m/z 57 are larger than 1, allowing NPP to be distinguished from primary emissions from biomass burning aerosol particles. Compared to corresponding virgin plastics, NPP emissions are more oxidized. Using the composition and dynamic trends of gas-phase emissions characterized by online chemical ionization mass spectrometry, we propose potential formation mechanisms of these NPP. We also estimated the emission factors of organic vapors and NPP, with a range of 33-430 g kg-1 and 0.5-828 g kg-1 respectively. This study is the first systematic characterization and quantification of NPP emissions from plastic smoldering combustion, which will aid identification of these particles in the atmosphere and assessment of their health and climate effects.

5CE.3

Chemical Characterization of Plastic Thermal Degradation Products Using Temperature Programmed Desorption − Direct Analysis in Real Time − High-Resolution Mass Spectrometry. EMILY HALPERN, Peter Christ, Killian MacFeeley, Lauren Heirty, Christopher P. West, Yitao Li, Won Kim, Anthony Mennito, Alexander Laskin, *Purdue University*

As the global demand for plastic grows, plastic management has become an environmental concern. Plastic burning processes are used as methods of disposing of plastic waste; however, plastic thermal decomposition releases a complex and poorly understood mixture of air pollutants that can condense into secondary organic aerosol. There is a pressing need to develop and implement efficient techniques to study the thermal decomposition of plastic samples. Here, we employ temperature-programmed desorption-direct analysis in real-time high resolution mass spectrometry (TPD-DART-HRMS) in both positive and negative ion modes to study four kinds of plastic standards, and three kinds of plastic wastes. CH_2 Kendrick mass defect (KMD) grouping was used to identify characteristic trends in the mass spectra acquired from each of the plastic samples and to better identify the products released during plastic thermal breakdown for common types of plastic: polyethylene, polypropylene, polystyrene, and polyvinyl chloride. We developed a statistical method based on the Tanimoto coefficient to compare the thermal decomposition products of unknown plastic waste with those of the plastic standards. Additionally, we were able to study the complex mechanisms of plastic thermal degradation. Arrhenius plots of extracted ion chromatograms (thermograms) were employed to deduce the apparent activation energies of thermal degradation of various products broken down and volatilized from polymer macromolecules of plastic. These values enable us to model gas-phase emissions from thermal decomposition of plastic and evaluate their propensity to form SOA in emissions from plastic burning events.

5CE.4

Atmospheric Microplastic Quantification with Automated Microspectroscopic Techniques.

REBECCA PARHAM, Abby Ayala, Lauren Meagher, Madeline Clough, Eduardo Ochoa, Jia Shi, Scarlet Aguilar-Martinez, Ambuj Tewari, Paul Zimmerman, Allison Steiner, Anne McNeil, Andrew Ault, *University of Michigan*

Microplastics (MPs), or pieces of plastic between 1-5000 µm in length, have been studied since the early 2000s and are considered globally ubiquitous; however, the atmospheric deposition of MPs has only been reported within the past decade. Research has since recorded MP fallout in both urban and remote locations across the globe, with deposition rates ranging from 0 to 1000s of MPs/m^2/day. Microspectroscopy techniques, notably infrared (IR) techniques, are the primary methods of identifying environmental MPs since they can obtain the physical properties of particles, such as their size and shape, in addition to their molecular composition. These techniques, however, cannot detect particulate matter less than 2.5 µm in diameter ($PM_{2.5}$), posing a significant limitation to the quantification of MPs in smaller size ranges. Herein, this study will utilize computer-controlled optical photothermal infrared spectroscopy coupled with Raman spectroscopy (CC-OPTIR+Raman) for the identification and quantification of atmospheric MPs. Not only can O-PTIR surpass the spatial limitations of traditional IR techniques and resolve particles down to 1 µm, but it can also be paired with a Raman spectrometer for simultaneous IR and Raman analysis. Moreover, the mIRage O-PTIR+Raman, the instrument used for this study, recently acquired the means to automate the detection and analysis of particles within a field of view. The analytical capabilities of CC-OPTIR+Raman for MPs was determined by analyzing a mix of laboratory-generated and ambient samples of increasing complexity. Acquisition of both PTIR and Raman spectra improved the overall identification capabilities of the method, demonstrating how the technique can be used to gain a better understanding of the general population's exposure to atmospheric MPs and their potential consequences to human health. Future work will apply CC-OPTIR+Raman to assess atmospheric MP concentrations in field samples collected in the Midwest region of the United States.

5CE.5

Probing the Processes that Govern the Direct and Indirect Climate Effects of Nanoplastics.

Katrina Betz, Habeeb Al-Mashala, Sithumi Liyanage, Micah Miles, Jace Barton, ELIJAH SCHNITZLER, *Oklahoma State University*

Plastic particles with dimensions in the nanometer range, or nanoplastics, have been shown to be emitted into the atmosphere over land and the ocean and transported long distances to remote regions. During their atmospheric residence time, nanoplastics may influence climate through the direct and indirect effects, but the combined magnitude and direction of these effects are unknown. Here, we describe a series of experiments designed to probe the processes that govern the direct and indirect climate effects of nanoplastics. Macroscopic plastics, commonly colored with azo dyes, are known to whiten with environmental exposure, and we have demonstrated that azo dyes undergo reactive uptake of ozone, so we expect the direct effect to depend on the rate of whitening in the atmosphere due to oxidants and irradiation. We generated colored nanoplastics using a heated nozzle from a 3D printer, deposited the particles on filters, and monitored the absorbance through the filters as a function of exposure to ozone at 30 ppb and irradiation in a UV-B photo-reactor and solar simulator. In the first 24 h of ozone exposure, the absorbance decreased by about 15%, and the remaining 85% persisted for subsequent exposure over the course of days, suggesting that only dye within a thin layer near the surface of the particles is susceptible to ozone. In contrast, the absorbance decreased rapidly and almost completely through irradiation. We have also investigated the partitioning of secondary organic aerosol from the ozonolysis of α-pinene onto nanoplastics. Results indicate that partitioning under dry conditions can give partially engulfed, rather than core-shell particles, and the coating increases the hygroscopicity of the core nanoplastics, likely enhancing their impact on cloud formation as well as increasing their wet deposition.

5CE.6

Pristine and Aged Microplastics Can Nucleate Ice through Immersion Freezing. HEIDI L. BUSSE, Devaka Ariyasena, Jessica Orris, Miriam Freedman, *The Pennsylvania State University*

Microplastics (MP) are ubiquitous in the environment—their atmospheric relevance being increasingly recognized. A recent question is whether MP can act as ice nucleating particles in the atmosphere. This study looks at the immersion freezing activity of lab-prepared MP of four different compositions (low-density polyethylene, polypropylene, poly(vinyl chloride), and polyethylene terephthalate) using droplet freezing assays. The MP are also exposed to ultraviolet light and ozone for environmental equivalents of up to 593 and 99 days, respectively, as well as sulfuric acid and ammonium sulfate to mimic environmental aging of the plastics to elucidate the role that these processes play in the ice nucleating activity of MP. Results show that all studied MP act as immersion nuclei and aging processes can modify this ice nucleating activity, leading to increases or decreases in ice nucleating activity. Chemical changes are monitored with infrared spectroscopy and the growth of a C=O peak is associated with a decrease in ice nucleating activity while a loss of an existing C=O peak is associated with an increase in ice nucleating activity. The MP studied here have ice nucleating activities sufficient to be a non-negligible source of ice nucleating particles in the atmosphere if present in high enough concentrations.

5CT.1

Longer-range Transport and Longer-term Aging of Biomass Burning Influenced Atmospheric Organic Aerosol. RACHEL O'BRIEN, Janie (Yeaseul) Kim, Corin Tyler, Emily Costa, Xu He, Yao Xiao, Andrew Ault, Manjula Canagaratna, Mitchell Alton, Benjamin A. Nault, Christopher Cappa, Cassandra Gaston, Ann M. Dillner, Haley Royer, Alyson Allen, Edmund Blades, Rebecca Chewitt-Lucas, *University of Michigan*

Brown carbon (BrC) in aerosol particles and cloud droplets can contribute to climate warming by absorbing solar radiation in the visible region of the solar spectrum. Large uncertainties remain in our parameterization of this warming, in part due to gaps in our knowledge of the atmospheric lifetimes of the light absorbing molecules in the mixtures. An important removal pathway includes chemical transformations that fragment the chromophore, thus removing its ability to absorb visible light. However, the photochemical loss rates measured in the laboratory are much shorter than what is observed in ambient measurements. There are also different amounts of photo-recalcitrant BrC, which is a fraction of the mixture that does not rapidly bleach. An important BrC source in the atmosphere is biomass burning and the overall photochemical decay rates for these emissions are important to quantify to improve our parameterizations for their radiative effects. In this talk, I will be combining results from photolysis studies in our lab, along with results of biomass burning influenced samples collected during AEROMMA that came from the Canadian wildfires and collected at Barbados that came from African wildfires.

5CT.2

Assessing the Accuracy and Reliability of Air Sensors for Quantifying Fine Particulate Matter during Wildfires at the Queens College ASCENT Site. DAVID HAGAN, Eben Cross, David McClosky, Sabrina Westgate, Roya Bahreini, Ann M. Dillner, Armistead G. Russell, Taekyu Joo, Mitchell Rogers, Tori Hass-Mitchell, Drew Gentner, Nga Lee Ng, *QuantAQ, Inc.*

Air sensors have become widely used for measuring fine aerosol ($PM_{2.5}$) and are increasingly relied upon by the general public during major air quality events, such as wildfires, to gauge risk and make decisions. While there is a general understanding that optical sensors must be corrected when making measurements of wildfire smoke, it is unclear how the exact physical and chemical properties of the particles impact PM_1 and $PM_{2.5}$ estimates. As biomass burning aerosol ages, the aerosol generally becomes larger and lighter in color as it is chemically processed. These changes in composition and size will affect the optical sensors' ability to accurately measure aerosol loadings as their calibrations are often based on non-light-absorbing aerosol of known composition. In this work, we present estimates for measurement uncertainty for PM_1 and $PM_{2.5}$ as characterized by air sensors of various types (e.g., nephelometers, optical particle counters, dual-detection, etc.) under varying wildfire smoke conditions across a range in aerosol optical and physical properties. We use a combination of modeled results (using the open-sourced *opcsim* Python library) and field data collected as part of the ASCENT (**A**tmospheric **S**cience and **C**hemistry m**E**aurement **N**e**T**work) project (e.g., particle size via SMPS, aerosol composition via ACSM, etc.) at the Queens College site during the 2023 wildfires on the US East Coast to support our conclusions.

5CT.3

Chemical Characterization and Source Apportionment of Organic Aerosol in New York City Using FIGAERO-CIMS and HR-ToF-AMS as Part of 2023 NYC-METS Campaign. TIANCHANG XU, Ruizhe Liu, Yutong Liang, Taekyu Joo, Mitchell Rogers, Mitchell Alton, Anandi Williams, Jo Machesky, Mia Tran, Minguk Seo, Andrew Lambe, Drew Gentner, Nga Lee Ng, *Georgia Institute of Technology*

The formation and evolution of organic aerosol (OA) are investigated as part of the summer 2023 NYC-METS (New York City metropolitan Measurements of Emissions and TransformationS) campaign from July to August 2023. We deploy two online instruments simultaneously to measure OA composition and concentrations: the high-resolution time-of-flight aerosol mass spectrometer (AMS) and the Filter Inlet for Gases and AEROsols coupled to a high-resolution time-of-flight iodide-adduct chemical ionization mass spectrometer (FIGAERO-CIMS). We conduct factorization analysis (PMF) of data obtained from both instruments to understand the sources of OA measured at the campaign. The speciated OA measurements by the FIGAERO-CIMS allow for additional new insights into the sources and composition determined from factor analysis on AMS data alone. Specifically, FIGAERO-CIMS data can aid in the determination of chemical oxidation reactions that lead to the formation of less-oxidized oxygenated OA (LO-OOA) and more-oxidized oxygenated OA (MO-OOA) because they offer molecular information of compounds, instead of fragments in AMS, that allows us to compare FIGAERO results directly with proposed reactants from different oxidation reactions. Both instruments capture aerosol formed from biomass burning events and at different oxidation states from LO-OOA to MO-OOA, but OA measured from FIGAERO-CIMS display a higher oxidation state due to the instrument's measurement selectivity to highly oxidized compounds. In addition, the molecular and volatility information from FIGAERO-CIMS factorization analysis can also identify the types of reactions, such as oxidation of phenolic compounds in biomass burning events, that contribute to SOA formation. Results from this study highlight the importance and advanced technical capability of deploying both HR-ToF-AMS and FIGAERO-CIMS in OA measurements to gain new insights into the sources and reactions contributing to OA emissions and formation.

5CT.4

Enhancements in Inorganic Aerosol Production in New York City and Downwind: Connecting In-Situ Oxidation Experiments with ASCENT Field Observations to Examine Key Chemical and Environmental Factors. TORI HASS-MITCHELL, Andrew Lambe, Mitchell Rogers, Taekyu Joo, Catelynn Soong, Jordan Krechmer, Benjamin A. Nault, Drew Gentner, *Yale University*

Despite representing only ~20% of $PM_{2.5}$ in U.S. urban areas with declining concentrations, inorganic aerosols have a significant influence on aerosol physicochemical properties. Episodic enhancements in secondary inorganic aerosols were observed following exposure to hydroxyl (OH) radicals in an oxidation flow reactor (OFR) coupled to an aerosol chemical speciation monitor (ACSM) at a receptor site in northern Manhattan, NYC during the summer 2022 NYC-METS (New York City metropolitan Measurements of Emissions and TransformationS) intensive. During the same period, relatively consistent minor enhancements in secondary organic aerosols were also observed. These results were compared to long-term baseline ACSM measurements at the ASCENT (Atmospheric Science and Chemistry mEasurement NeTwork) network site in Queens, NYC. Environmental and meteorological factors, including relative humidity and its impacts on aerosol liquid water, as well as reactive precursor concentrations, were found to be key factors influencing the episodic inorganic enhancements across all seasons. These results highlight the significance of NO_x and SO_2 emissions in the NYC region and inform the importance of continued attention to inorganic species in research and $PM_{2.5}$ control policies in NYC, downwind areas, and other similar regions.

5CT.5

Variations in Summertime Aerosol Physicochemical Mixing State Observed during NYC-METS. EMILY COSTA, Yao Xiao, Xu He, Corin Tyler, Kayleigh Reilly, Tiantian Zhu, Jessica Mirrielees, Drew Gentner, Rachel O'Brien, Andrew Ault, *University of Michigan*

Air pollution in densely populated urban and downwind areas poses a significant threat to human health. Airborne particulate matter (PM) in these regions can be produced in a variety of ways, including from both primary and secondary processes. Secondary organic aerosol (SOA) is known to contribute to poor summertime air quality, and its formation is driven by the emission of gas-phase organic compounds, including volatile organic compounds (VOCs). VOC emissions in urban areas are evolving such that non-traditional sources including volatile chemical products (e.g., paints, personal care products) may now be more prominent SOA precursors. In order to understand summertime SOA formation under these changing conditions, single-particle analysis is needed to characterize the chemical composition, sources, and physicochemical mixing state of airborne PM in a variety of locations. Simultaneous size-resolved atmospheric particle sampling was conducted in New York City, NY and in downwind Guilford, CT as part of the New York City metropolitan Measurements of Emissions and TransformationS (NYC-METS) campaign in summer 2023. The chemical composition of individual atmospheric particles collected at each site was examined using a variety of offline microscopic and spectroscopic techniques, including scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDX), and simultaneous optical-photothermal infrared spectroscopy (O-PTIR) and Raman microspectroscopy. These analyses reveal clear compositional differences between the two sampling sites, suggesting different sources and aging mechanisms of airborne PM.

5CT.6

Highly-Oxidized Secondary Organic Aerosol in Coastal Communities Downwind of New York City: Influence of Over-Water Production and Transport. MITCHELL ROGERS, Anandi Williams, Keerthana Chari, Tori Hass-Mitchell, Colby Buehler, Heather LeClerc, Catelynn Soong, Anita Avery, Mitchell Alton, Jo Machesky, Taekyu Joo, Manjula Canagaratna, Andrew Lambe, Drew Gentner, *Yale University*

Emissions of aerosols and their reactive precursors from New York City and other Mid-Atlantic urban areas often travel across the Long Island Sound and undergo over-water oxidative transformations, leading to regional enhancements in secondary pollutants for these downwind communities. Using summer 2023 observations from the Yale Coastal Field Station in Guilford, CT as part of the NYC-METS 2023 (New York City metropolitan Measurements of Emissions and TransformationS) and AEROMMA 2023 (Atmospheric Emissions and Reactions Observed from Megacities to Marine Areas) campaigns, we examine the impacts of reactive anthropogenic, biogenic, and marine emissions and multiphase oxidative chemistry on secondary organic aerosol (SOA) reaching downwind coastal regions. Time-resolved gas and particle-phase measurements via a Proton-Transfer-Reaction Time-of-Flight Mass Spectrometer (PTR-ToF-MS) and Aerosol Chemical Speciation Monitor (ACSM) are used to explore enhancements in oxygenated organic aerosol (OOA) and their variations with emissions and meteorology. The results of online analysis are also compared to the offline analysis of functionalized organic particle-phase compounds using gas and liquid chromatography with tandem mass spectrometry. We examine differences in oxidized aerosol composition and molecular functionalities that vary with on-shore versus off-shore flow, as well as with backward air mass trajectory clusters, and often arrived in single or multi-day events coincident with elevated ozone. For example, periods of on-shore flow brought 1+ $\mu g\ m^{-3}$ enhancements in OOA concentrations that were more oxidized on average ($f_{44}/f_{43} = 2.7$) and represented by a spectrum of OOA source factors as determined via source apportionment with positive matrix factorization. The influence of oxidized SOA downwind of densely-populated urban areas is assessed across the summer 2023 campaign and in the context of changing emissions and climate.

5CT.7

Evaluation of CMAQ-Predicted Gas Phase Water Soluble Organic Carbon. ELLIE SMITH, Kirk Baker, Christopher Hennigan, Marwa El-Sayed, Annmarie Carlton, *University of California, Irvine*

Gas phase water soluble organic carbon (WSOCg) comprises many important trace species critical for Secondary Organic Aerosol (SOA) formation. The Community Multiscale Air Quality (CMAQ) model predicts aqueous pathways dominate SOA mass in the eastern U.S. In this work, we evaluate CMAQ's predictive skill for accurate representation of WSOCg. We pair model predictions of WSOCg in space and time for 3 months of continuous mist chamber sampling in Baltimore, MD with retrospective CMAQ simulations for the eastern U.S. We sample CMAQ's atmosphere with a virtual mist chamber, applying collection efficiencies as a function of Henry's Law, and accounting for each individual species' solubility and sampling bias. CMAQ predictions do not replicate the average diurnal pattern of measured WSOCg in any month and are generally biased low relative to measurements, especially in winter. However, parent volatile organic compounds (VOCs), NO2 and ozone predictions evaluate well compared to measurements at a nearby EPA Photochemical Assessment Monitoring Station (PAMS) site in a neighboring model grid cell, ($r = 0.5$; $r = 0.7$; and $r = 0.8$, respectively and all p values ≈ 0). CMAQ-predicted WSOCg is significantly ($p \approx 0$) and positively correlated to model-predicted NOx ($r = 0.9$ in February/March; $r = 0.5$, in August) and exhibits similar morning and evening peaks. Measured WSOCg mass is significantly ($p \approx 0$) correlated with temperature in the summer ($r = 0.7$), but not in winter. Modeled WSOCg concentrations are correlated with temperature in both seasons. These findings suggest that CMAQ represents VOC reactivity for ozone formation well, but not the processing that produces WSOCg, a dominant contributor to SOA in the region.

5IM.1

Practical Considerations for Tandem Aerosol Classifier Measurements: The Effect of Scan Time, Resolution, and Calibration on Effective Density Accuracy. Morteza Kiasadegh, Timothy Sipkens, Jonathan Symonds, JASON S. OLFERT, *University of Alberta*

This study systematically investigates the influence of resolution, measurement time, and calibration method on the accuracy of tandem aerosol classifier measurements of effective density. We investigate tandem combinations of the centrifugal particle mass analyzer (CPMA), aerodynamic aerosol classifier (AAC) and differential mobility analyzer (DMA), where the downstream classifier is a scanning instrument (scanning DMA (SMPS) or scanning AAC (SASS)). The impact of scan time depends on the classifier and its flow rate. For low-flow measurements (0.3 LPM) with a TSI 3776 particle counter, scan times greater than 2.4 and 5.1 minutes per size decade should be used for the SMPS and AAC, respectively. For high-flow measurements (1.5 LPM), scan times greater than 0.3 and 2.4 minutes per decade should be used for the SMPS and AAC, respectively. Measurements at lower resolutions (mass resolution of Rm = 2, and mobility or relaxation time resolution of Rs = 7) introduce significant errors. Conversely, medium (Rm = 6, Rs = 18) and high-resolution (Rm = 15, Rt = 45) settings produce nearly the same result. Using a high sample flow or high resolution enhances effective density accuracy but leads to a notably narrower measurement range. By determining the effective density of a spherical particle with a known material density (e.g., DOS), a calibration factor can be derived by comparing the measured density to the actual material density for each particle diameter. This allows for more robust instrument calibration. Using calibration, it was found that particles densities could be measured within ~5–7% of the actual material density. These findings demonstrate that using a scanning downstream classifier can yield accurate effective density measurements in a relatively short time if the tandem system is configured appropriately.

5IM.2

Advancing Low-cost Air Quality Monitor Calibration with Artificial Intelligence. SINAN SOUSAN, Rui Wu, Ciprian Popoviciu, Sarah Fresquez, Yoo Min Park, *Department of Public Health, East Carolina University*

Low-cost sensors used for measuring airborne contaminants have become popular in recent years due to their price, portability, and ease of use. However, these sensors often exhibit high biases compared to their expensive counterparts and are often calibrated using a high-cost or reference instrument. Calibration models are affected by aerosol type, composition, and particle size, which render calibration models ineffective outside the original calibration environment. Therefore, low-cost monitors must be calibrated and validated in their immediate environment for best accuracy, which can be challenging due to high-costs and limited availability of reference instruments nationwide. This work proposes a novel machine-learning calibration method that uses one high-cost instrument with groups of low-cost sensors to perform the calibration. The machine learning methods employed were random forest and Gradient boosting trees, which were compared with simple linear regression. The conceptual model was demonstrated in a chamber study using three electronic cigarette (ECIG) brands that generate different aerosol and volatile organic compounds (VOC) exposures while performing measurements with 30 low-cost GeoAir2 monitors, forming 10 groups with 3 monitors in each group, with the personal Data Ram (pDR-1500) and MiniRAE high-cost monitors. The proposed method employed two groups of regression models. The first can be built by collocating all groups with the high-cost monitor using the first ECIG brand. Then, the regression models of 9 groups, except group 1, were used to measure the exposure of the second and third ECIG brands while applying errors calculated from group 1 and the high-cost monitor with a second set of regression models. The method showed a substantial improvement in some cases, up to 109% increase in r^2 and 45% and 41% decrease in RMSE and precision values, respectively, depending on the machine learning model used. This work shows promising results that can be applied in environmental studies

5IM.3

Particles in the Upper Troposphere and Lower Stratosphere (PUTLS): Observations of Aerosol Microphysical Properties.

MATTHEW BROWN, Luke Ziemba, *NASA*

Aerosol particles play a critical role in modulating Earth's radiative balance through direct scattering of visible light and the formation of clouds. While nearly all emissions occur near the Earth's surface, transport of aerosols and gases into the upper troposphere and lower stratosphere (UTLS) leads to secondary production, important heterogeneous chemistry, and increased particle lifetimes that magnify climate effects. Airborne measurements of aerosol microphysical properties are critical for understanding these processes and validating the global models used to predict climate. We provide an overview of the development of an in-situ, autonomous, high-altitude aircraft-based instrument package called PUTLS (Particles in the UTLS) that measures particle size distributions.

As a new capability for the LARGE (Langley Aerosol Research Group) team at NASA Langley Research Center, PUTLS has flown on the NASA WB-57F, DC-8, and P-3 aircraft in a series of campaigns from 2022-2024. Instrument package overview, novel data reduction algorithms, and applications to observations from these flights will be discussed.

5IM.4

Integrating Data from Satellites and Low-Cost Sensors to Investigate Stubble Burning Effects on Air Quality in Lower Rio Grande Valley, Texas, USA.

SAI DEEPAK PINAKANA, Amit U. Raysoni, Alqamah Sayeed, Pawan Gupta, *The University of Texas Rio Grande Valley*

The Lower Rio Grande Valley (RGV) region of South Texas includes Hidalgo, Cameron, Willacy, and Starr counties, and is home to 1,399,446 people (Census Bureau 2022). This area is a majority-minority community with Hispanics/Latinos making up 91.8% of its population.

The Texas Commission on Environmental Quality (TCEQ) which is the environmental agency for the state operates five Central Ambient Monitoring Site (CAMS) stations, one each in the cities of Brownsville, Edinburg, Harlingen, Mission, and Port Isabel. Two CAMS stations monitor O3 and four monitor PM2.5. The CAMS sites are inadequate in characterizing accurate levels of air pollution exposure for the 1.3 million individuals living in the region. According to the USEPA's National Ambient Air Quality Standards (NAAQS) for new annual PM2.5 standards (9.0 µg/m3, announced on February 7, 2024), Hidalgo and Cameron counties are now not in compliance (USEPA, 2024).

The Rio Grande Valley annually produces 1.5 million tons of sugarcane in the continental United States. To facilitate the harvesting of sugar-rich stalks, farmers burn the same during the pre- and post-harvest season every year. As part of a NASA ROSES 2022 grant, this project integrates data from NASA satellites and ground-based monitoring stations to assess PM2.5 trends due to agricultural burning in this region. Aerosol Optical Depth (AOD) collected by GOES is supplemented by 20 low-cost purple air monitors deployed in various regions to evaluate the air quality trends. Spatial and temporal patterns of the burning activities recorded by the satellites will be presented, along with the data collected as part of this research project. This project is based on the premise that high exposures to air pollutants is a matter of environmental injustice especially for this low-resourced, Spanish-speaking, majority minority region of the U.S.-Mexico border.

5IM.5

A Compact Aerosol Mobility Imager for Instantaneous Aerosol Size Distribution Measurements. JIAOSHI ZHANG, Jing Li, Xiaoyu Chen, Steven Spielman, Susanne Hering, Jian Wang, *Washington University in St. Louis*

Aerosol Mobility Imager (AMI), a compact instrument for rapid measurements of aerosol size distribution, is presented. AMI employs a parallel plate mobility separator wherein the electric field strength varies along the width of the plate. Under the influence of the electric field, charged particles are spatially separated inside the separator according to their electrical mobility. An extraction growth cell (EGC) then extracts a portion of the flow carrying the spatially separated particles and converges the extracted flow into a narrow focusing nozzle slit, while simultaneously growing the particles by water condensation. Grown particles exiting the focusing slit are imaged to capture both the number and mobility dependent position of the particles, which allows for derivation of aerosol size distribution. The employment of the new EGC greatly reduces the instrument size, weight, and power consumption compared to the previously developed Fast Integrated Mobility Spectrometer (FIMS) (Wang et al., 2017a; Wang et al., 2017b). The combination of a compact size and fast measurement speed makes AMI an ideal instrument for deployments in many laboratory studies and field observations, including onboard platforms such as the unmanned aerial vehicle and tethered balloon system. Here, we present the numerical simulations and experimental characterizations of the newly developed AMI. The particle trajectories and growth of spatially separated particles inside AMI were simulated and the AMI transfer function, mobility resolution, and transmission efficiency were derived based on the simulated particle trajectories. A prototype AMI was constructed, and the simulated AMI performances including mobility sizing accuracy, detection efficiency, and transfer functions were validated experimentally using DMA-classified aerosols. The results demonstrate that AMI is capable of rapid and accurate aerosol size distribution measurement, while maintaining a sufficient mobility resolution for measurements of ambient aerosols.

5IM.6

A Semi-Analytical Model of the Scanning Transfer Function for Radial-Flow Differential Mobility Analyzers. STAVROS AMANATIDIS, Yuanlong Huang, Richard Flagan, *Aerosol Dynamics Inc.*

Differential mobility analysis (DMA) is a well-established measurement technique that provides size-classification of aerosol particles according to their electrical mobility. In the DMA, charged particles in the incoming flow are separated as they pass through an electric field between two electrodes which is varied to enable classification of different particle mobilities.

A common DMA application is its use as part of a Scanning Electrical Mobility Spectrometer, wherein the DMA electric field is varied in a continuous exponential voltage ramp and the output aerosol concentration is detected by a particle counter. The measured response is then reduced to size distribution data by an inversion routine that requires input information of the various instrument parameters. A key parameter in this process is the DMA transfer function, the particle transmission probability through the DMA as a function of input particle mobility and instrument operating parameters. While an analytical model of the transfer function for radial-flow DMAs has been previously described in a steady-state applied electric field (“static” mode), no model is currently available for operating the instrument in “scanning” voltage mode.

In this work, we present a semi-analytical model of the scanning transfer function for radial-flow DMAs. The model is derived for fully-developed laminar flow and takes as input the physical dimensions of the classifier geometry, operating flow rates, scanning voltage rate, as well as the input particle mobility. We demonstrate the characteristic particle trajectories in the DMA and how those vary with scanning parameters. Using the geometry characteristics of an actual radial-flow DMA, the transfer functions predicted by the model are compared against finite element modeling results across a range of operating parameters, for both increasing (upscans) and decreasing (downscans) voltage ramps, as well as against the “static” transfer function model.

5IM.7

Evaluating 'Good Enough' - An introduction to US EPA Air Sensors NSIM Guidelines and Assessment of Its Utility for Research and Community Air Monitoring Applications. EBEN CROSS, David Hagan, David McClosky, Adriana Peña, Shivang Agarwal, Kirsten Koehler, Peter F. DeCarlo, *QuantAQ, Inc.*

Recently, the US Environmental Protection Agency (US EPA) released their air sensor performance targets for Non-Regulatory, Supplemental, and Informational Monitoring applications for use outdoors and at fixed locations. These guidelines are an important benchmark for the deployment of air sensors by researchers, regulators and community-based organizations seeking to understand health risk and mitigate local air pollution sources. Despite this progress, challenges and limitations of the NSIM guidelines remain including performance metrics that are too broadly defined, hourly specifications in the context of minute-level pollution transients, and evaluation criteria that fail to reveal fundamental limitations of some sensors.

In this work, we use data from three distinct co-location environments (Baltimore City, MD; Marcus Hook, PA; Rubidoux, CA) to explore whether the new guidelines set data quality goals that are relevant for practical use cases including community and near-reference, sub-regulatory applications. In using data from three distinct environments, we are able to systematically explore the performance of real air sensors across environments that challenge the protocols outlined by EPA. We present recommendations for improvement and call for alternative protocols to ensure coarse aerosol can be reliably measured using air sensors.

5SC.1

Portable Aerosol Instrument Calibrator. FRED BRECHTEL, Andy Corless, Xerxes Lopez-Yglesias, *Brechtel Mfg. Inc.*

The proliferation of low-cost aerosol sensor networks and the field deployment of research-grade aerosol instruments motivates the development of a **P**ortable, **L**ow-cost, and **EAS**y-to-use **CAL**ibration (PLEASCAL) system. The device described here is completely self-contained, with aerosol generator, dryer, charge neutralizer, particle size selector, and particle counter. PLEASCAL requires no external pumps or power and is the size of a piece of carry-on luggage.

PLEASCAL is built around a Brechtel Model 9404 mini-SEMS that has been modified to use an injection molded DMA. A Model 9403 advanced Mixing CPC is used as the particle detector. A micro-computer and software control PLEASCAL, communicates with the device under test, and generates a report with test results. Impactors are used to reduce the influence of multiply charged particles on the uncertainty in delivered mass concentrations. The complete system is packaged inside a small weatherproof pelican case.

PLEASCAL operates in two testing modes: monodisperse mode, where the device under test is challenged with known size, concentration, and composition aerosol generated by PLEASCAL; and polydisperse mode, where the polydisperse number size distribution is measured and the device under test is challenged with the same distribution. The system is designed to validate electrometers and CPCs (total number concentration), scanning electrical mobility sizers (number size distribution), mass spectrometers and other particle mass measurements (total mass for particles smaller than 500 nm), and light absorption photometers (light absorption coefficient and absorbing aerosol mass concentration).

To demonstrate PLEASCAL, example validation tests of a Model 1720 MCPC and a Model 2100 SEMS will be performed.

5SC.2

Application of Thermal Desorption, Broadband Cavity Ring-Down Spectroscopy for In-Field Measurements of Speciated VOCs.

AURELIE MARCOTTE, Michael Armen, Jake Margolis, Anthony Miller, *Entanglement Technologies, Inc*

In-field, real-time analysis for measuring volatile organic compounds (VOCs), including air toxics or hazardous air pollutants (HAPs), at relevant ambient air concentrations is growing in popularity as it has many advantages over traditional methods (e.g. grab samples followed by lab analysis). This presentation will review the application of Entanglement Technologies' AROMA analyzer, a thermal desorption, broadband cavity ring-down spectroscopy (TD-CRDS) system used to measure a variety of air toxics and contaminants of emerging concern (e.g. ethylene oxide). AROMA provides real-time part-per-trillion chemical detection in ambient air, soil gas, sewer headspace, and other complex, real-world sampling environments. TD-CRDS is particularly well suited to air quality measurements where real-time, laboratory-grade results enable rapid decision making as well as where mobility and long-term stand-alone operation provide significant advantages over traditional sampling methodologies. The intrinsic stability of the CRDS analyzer core minimizes maintenance and calibration requirements greatly reducing instrument operation overhead. Specific topics to be covered in the presentation include AROMA analyzer development and performance validation to measure benzene, toluene, ethylbenzene, xylene(s) (BTEX), ethylene oxide, trichloroethylene, and other VOCs at relevant atmospheric concentrations. Results from ambient air monitoring campaigns from locations across the U.S. will also be included.

5SC.3

Real-time Partitioning of Organic Acids Using an Ambient Ion Monitor: Opportunities and Challenges Presented by Addition of a Mass Spectrometer. TREVOR VANDENBOER, Mayré Rodriguez Ramirez, Eric Vanhauwaert, Jessica Clouthier, Shira Joudan, Cora Young, *York University*

Organic acids in the atmosphere are formed after the oxidation of volatile organic and chemical compounds; the most abundant organic acid is formic acid. Trifluoroacetic acid (TFA) is a fluorinated organic acid that has been found in the atmosphere; it is a persistent compound and is resistant to environmental degradation.

A few techniques have been developed to measure organic acids in the gas and particle phase, restricted to offline, highly time-integrated, and subject to sampling biased methods. We developed a new technique to simultaneously measure trace levels of organic acids in the gas and particle phase (<2.5 µm) in real-time using an ambient ion monitor (AIM) coupled to an ion chromatograph (IC) and a mass spectrometer (MS), that with the use of different internal standards (IS), quantifies lower atmospheric amounts with greater accuracy.

The AIM-IC-MS is a world-unique online instrument that samples air hourly, an IC with anion and cation columns and conductivity detectors, and a single quadrupole mass spectrometer (MS) as a second detector for anions to separate and measure the conjugated base of water-soluble organic acids that cannot typically be resolved in under 30 minutes. Typical major ions in ambient air vary in abundance and cause co-elution and ion suppression in the MS. For this reason, bromide, 13C2 TFA, and acetic acid-d3 are added as IS in both gas and particle samples.

The AIM-IC-MS was used during the Toronto Halogens, Emissions, Contaminants, and Inorganics eXperiment (THE CIX) campaign in Toronto during July and August 2023. We will show how the system expands the suite of quantifiable analytes and use of IS impacts the accuracy of the measurements, focusing on TFA and formic acid. How to properly select the correct IS for each desired analyte will be discussed.

6AC.1

Exploring the Hygroscopicity, Phase State and Morphology of Biomass-Burning and Brown Carbon Aerosol Particles. PRAKRITI SINGH, Malsha Amugoda, James F. Davies, *University of California, Riverside*

Atmospheric aerosols impact air quality, human health, visibility, cloud physics, and global climate. Biomass burning, an important source of aerosols and gas phase emissions, can produce significant amounts of brown carbon (BrC), a class of organic compounds that absorb light at visible wavelengths (<450 nm). BrC aerosol contain a mixture of water-soluble compounds, such as nitroaromatics, imidazoles, other oxygen-rich molecules with conjugated structures, and inorganic ammonium, nitrate, chloride, sulfate salts. Their physical characteristics, including size, refractive index, and phase morphology, are influenced by the prevailing environmental relative humidity (RH) and chemical composition. In this work we report the hygroscopicity of mixtures of organic components using an electrodynamic balance to perform single-particle levitation. We measure hygroscopicity of levoglucosan, phthalic acid, and 4-nitrocatechol, internally mixed with inorganic salts, such as (NH)2SO4, NaCl, KCl, and K2SO4. Measurements of hygroscopicity are compared to predictions using the ZSR mixing rule and to semi-empirical predictions using the AIOMFAC model. Our measurements show that hygroscopic BrC particles in mixtures with inorganic salts will exist in the form of a homogenous aqueous solution at high RH. However, they may undergo liquid-liquid phase separation (LLPS) and/or partial solidification at low RH, leading to a range of possible phase states with implications for their evolving role in the atmosphere, such as their optical characteristics and the reactivity of chromophores towards photolysis. Finally, we explore the hygroscopic growth and phase of particles containing BrC compounds that form during aqueous phase chemistry in dilute aqueous solutions representative of cloud droplets. Overall, this work seeks to connect the molecular composition of particles with their physiochemical properties to better inform their role in the atmosphere, their effect on air quality, and their interactions with solar radiation.

6AC.2

Single-Particle Distribution and Aging of Organic Compounds in Wildfire Emissions. Johannes Passig, Ellen Iva Rosewig, Aleksandrs Kalamasnikovs, Haseeb Hakkim, Marco Schmidt, Thomas Gröger, Mika Ihalainen, Anni Hartikainen, Markus Somero, Pasi Yli-Pirilä, Olli Sippula, Kerneels Jaars, Pieter Gideon van Zyl, Kajar Köster, Stefan Siebert, Saara Peltokorpi, Angela Buchholz, Liqing Hao, Annele Virtanen, Ville Vakkari, Andreas Walte, RALF ZIMMERMANN, *Mass Spectrometry Centre;Rostock University/Helmholtz Munich*

Widfires emit large quantities of CO2, reactive trace gases, and particulate matter, which have profound impacts on air quality, human health, and climate (Yue et al., 2018). The atmospheric aging and aerosol distribution of these substances are highly complex and variable. Moreover, the photochemical changes they undergo are of great relevance to climate and human health, as they determine the particle's optical and radiative effects, cloud condensation activity, and biological effects. A more comprehensive understanding of these effects requires information on the mixing state of the aerosol, i.e. the distribution of the constituents over the particle ensemble.

The advent of resonance-enhanced ionization in single-particle mass spectrometry (Passig et al., 2020 & 2022; Schade et al., 2019) has ushered in a new era of unprecedented access to single-particle chemical distribution information.

We studied particles from the smoke from wildfire simulation burns and the effect of photochemical aging. Typical vegetation from e.g., the boreal forest and the African savannah were used as fuels. For climate- and health-relevant PAHs we found high concentrations of the softwood combustion marker retene in boreal forest burns and its rapid degradation during aging. The toxic, unsubstituted PAHs showed higher stability against photooxidation. Particles with the highest PAH loads were observed in the long-range transported size mode even after prolonged aging, in agreement with a previous ambient air study (Passig et al., 2022). For the water-soluble components, we could show the emission and time-resolved formation of glyoxal/methylglyoxal during photochemical chamber aging. Interestingly, a non-uniform mixing of water-soluble glyoxal/methylglyoxal and non-polar PAH was observed. While the cloud condensation nucleation (CCN) activity of boreal forest emissions was increased by photooxidation, the CCN activity of African fuel emissions was reduced. This counterintuitive result may be explained by the observed sulfatization of potassium chloride to the less hygroscopic potassium sulfate during aging.

6AC.3

The Chemical Fate of Sulfur in Thiophene Against Nitrate Radical Oxidation. MICHAEL LUM, Kunpeng Chen, Bradley Ries, Linhui Tian, Raphael Mayorga, Yumeng Cui, Nilofar Raeofy, David Cocker, Haofei Zhang, Roya Bahreini, Ying-Hsuan Lin, *University of California, Riverside*

Sulfur-containing volatile organic compounds (VOCs) emitted during wildfire events have been shown to form secondary organic aerosols (SOA) upon atmospheric oxidation. Particle phase sulfurous products resulting from dimethyl sulfide or SO_2 multiphase reactions have been well characterized due to their contribution to inorganic sulfate (SO_4^{2-}) and surfactant-like sulfurous product concentrations; however, little is known about the fate of sulfur in other reduced organosulfur species relevant to wildfire emissions. As a model organosulfur compound emitted from wildfires, this study aimed to determine the product distribution of sulfur in atmospheric oxidation of thiophene and the empirical identities of the major organosulfates and sulfonates formed. A unique combination of instrumentation, including a mini aerosol mass spectrometer (mAMS) was used to determine the fate of sulfur under a $[NO_2]/[O_3]$ ratio of 0.1, representative of atmospheric conditions within wildfire plumes. Traditionally the mAMS cannot distinguish between inorganic and organic sulfate, so IC was first used to constrain the SO_4^{2-} concentrations. In addition, signals from mAMS measurements were deconvoluted using a linear combination of sulfur-containing standard fractionation to approximate the fractions of inorganic sulfate, organosulfates, and sulfonates. Empirical formulae of major organosulfate and sulfonate compounds were identified and confirmed through non-target search employing multiple MS techniques. With the constraint from IC measurements, our results indicated that sulfur-containing particle mass consisted of 27.7% inorganic sulfate and 72.3% organosulfate/sulfonates. The mAMS fractionation approach attributed 60.1% of sulfur product mass to sulfonates, 15.4% to organosulfates, and the remaining 24.5% to SO_4^{2-}. The organic fraction was determined to consist of C1-C8 organosulfates and sulfonates, with the majority being ≤C4 unsaturated compounds. Overall, this study highlights the nitrate radical oxidation of thiophene and its derivatives as a source of inorganic sulfate and organic sulfur compounds, which have important implications on the atmospheric S budget and aerosol/droplet physical and chemical properties.

6AC.4

Noncovalent Interactions in Brown Carbon Surrogates Lead to Enhanced Absorption of Visible Light. COLTON CALVERT, Holly Anthony, Nathan Huskins, Micah Miles, Elijah Schnitzler, *Oklahoma State University*

Biomass burning produces brown carbon, which absorbs visible light. However, there is an ongoing debate if the non-covalent interactions in brown carbon aerosol give rise to charge-transfer complexes, leading to additional absorbance. Guaiacol and its derivatives are known to be the most abundant products of biomass burning from gymnosperms, while benzoquinone and naphthoquinone are also well-known components of brown carbon. Furthermore, the electron donating groups on guaiacol and electron withdrawing groups on the quinones lead to an increased likelihood of the formation of a charge-transfer complex. Using UV-vis spectroscopy, we demonstrated complexation when the components are mixed in n-heptane, which serves as a proxy of the non-polar organic phase of biomass burning organic aerosol. Enhanced light absorption occurred instantaneously upon mixing and did not change with time. However, absorbance did change with temperature, and the initial absorbance was recovered simply by returning to the initial temperature. Furthermore, gas phase quinones are shown to partition into liquid guaiacol and guaiacol-like compounds to form charge-transfer complexes, and photoacoustic extinctiometer measurements are used to explore complexation in the aerosol phase. From these measurements, the physical and optical properties of the complexes are calculated, providing insight into the potential contributions of charge-transfer complexes to the total absorbance of brown carbon.

6AC.5

Formation and Properties of Secondary Organic Aerosol from Gas-Phase and Aqueous-Phase Oxidation of Substituted Phenolic Compounds. Claire E. Moffett, Zezhen Cheng, Gregory W. Vandergrift, Jie Zhang, Swarup China, ManishKumar Shrivastava, Gourihar Kulkarni, ALLA ZELENYUK, *Pacific Northwest National Laboratory*

Phenols, emitted from biomass burning, contribute significantly to secondary organic aerosol (SOA) formation through gas-phase chemistry and multiphase chemistry in aerosol liquid water and clouds (aqSOA). We will present the results of a recent study, in which we investigated four phenolic compounds (guaiacol, syringol, guaiacyl acetone (GA), and syringol acetone (SA)) that represent some of the important potential sources of SOA. GA and SA served as examples of highly soluble substituted phenolic compounds that have uptake coefficients of 10^{-4} and 10^{-2}, respectively, and can form significant amounts of aqSOA, which is comparable or even higher than the gas-SOA.

The experiments were conducted at low (<5%) and elevated (~50%) relative humidity (RH) with and without ammonium bisulfate seeds. Single particle mass spectrometer, miniSPLAT, was used to measure density, shape, composition, viscosity, and evaporation kinetics of size- and mass-selected particles. In addition to real-time particle characterization, SOA particles were collected on the filters for offline analysis by microscopy, high-resolution mass spectrometry, and for characterization of their optical properties.

We find, for example, that GA-SOA particles formed by gas-phase oxidation of guaiacyl acetone at low RH are highly viscous: larger particles represent aspherical agglomerates of spherical nanoparticles that at low RH do not coalesce even after 24 hours. At high RH (75%) these aspherical particles rapidly coalesce to form spherical particles. GA-SOA particles also have very low volatility. Particles lose only 30% of their volume after >24 hours of evaporation at 75% RH, and do not shrink at all during the same evaporation time at low RH. In comparison, all SOA particles formed by gas oxidation of guaiacol are spherical and have higher volatility: they lose 29% and 46% of their volume after >24 hours of evaporation at low and high RH, respectively. GA-SOA formed in the presence of ammonium bisulfate seeds forms spherical particles that contains organosulfates and have core-shell morphology. These particles lose ~ 20% and 40% of their volume after >24 hours of evaporation at low and high RH, respectively. The measurements of SOA optical properties indicate that in all cases, GA-SOA particles composed of high fraction of high molecular weight compounds, including light absorbing brown carbon.

6AC.6

Characterization of Oxygenated Volatile Organic Compounds and Secondary Organic Aerosol Generated from the Oxidation of Biogenic and Biomass Burning Precursors by Nitrate Radicals in an Oxidation Flow Reactor. Andrew Lambe, CHASE GLENN, Bin Bai, Anomitra De, David Pando, Nga Lee Ng, Drew Gentner, Pengfei Liu, *Aerodyne Research, Inc.*

The importance of nitrate radicals (NO_3) as a nighttime atmospheric oxidant is well established. For decades, laboratory studies investigating gas-phase NO_3 chemistry have utilized the same $NO_2 + O_3$ reactions and/or N_2O_5 thermal decomposition to produce NO_3 as it occurs in the atmosphere and accommodated the inherent limitations associated with N_2O_5, namely, that it must be generated and stored under cold and dry conditions until use. Recently, we developed a novel photolytic source of gas-phase NO_3, in which it is generated via irradiation of aerated aqueous solutions of ceric ammonium nitrate and nitric acid. Here, we applied the method to generate and measure the yield and chemical composition of oxygenated volatile organic compounds (OVOCs) and secondary organic aerosol (SOA) obtained from NO_3 oxidation of VOCs emitted from biogenic sources (isoprene, β-pinene, limonene and β-caryophyllene) and from biomass burning sources (phenol, catechol, guaiacol and syringol) in an oxidation flow reactor (OFR). Where possible, the composition and yields of OVOC/SOA obtained in the OFR studies were compared to those obtained from NO_3 oxidation of the same precursors in environmental chamber studies.

6AC.7

Evaporation-induced Brown Carbon Formation in Secondary Organic Aerosols: Effects of Drying Conditions and Gas-phase Precursors.

Nethmi Kasthuriarachchi, Laura-Helena Rivellini, ALEX K.Y. LEE, *Environment and Climate Change Canada*

Aqueous-phase processing of secondary organic aerosols produced from dark ozonolysis of limonene (limonene-SOA) can lead to brown carbon (BrC) via reactions with reduced nitrogen species. While many previous studies have investigated BrC formation from limonene-SOA in bulk solutions, little is known about their formation behaviour in aerosol/cloud droplets upon evaporation and in the presence of other SOA precursors. This work illustrates that co-oxidation of limonene with other biogenic (α-pinene) or anthropogenic (toluene) VOCs by ozone produce SOA that are more effective in BrC formation compared to those observed in limonene-SOA alone when the SOA extracts are dried in bulk solutions with ammonium sulfate/glycine. Our results also show that drying of SOA droplets produced by atomization of limonene-SOA and limonene-toluene-SOA extracts with ammonium sulfate/glycine can result in significant BrC formation in the time scale of seconds, and the BrC absorbance and product distribution vary as a function of relative humidity (RH) for both chemical systems. Starting from low values in the high RH condition (e.g., > 90%), the mass absorption efficiency (MAE) of evaporated SOA droplets increase with decreasing RH and reach a maximum at intermediate RH, and then reduce at lower RH conditions (e.g., < 65%). We hypothesise that rapid re-partitioning of semi-volatile BrC precursors in limonene-SOA may occur upon drying, limiting the multi-step oligomerization mechanism for producing BrC with longer wavelength absorption. Overall, this study highlights the potential effect of VOC mixtures on aqueous-phase BrC formation, and the need of more studies that mimic atmospherically relevant drying conditions to better understand BrC chemistry via aqueous aerosol and in-clouding processing.

6AC.8

Ammonium-Induced Stabilization of Imidazoles in the Particle Phase.

MALSHA AMUGODA, James F. Davies, *University of California, Riverside*

Imidazoles (IMs) are semi-volatile organic compounds (SVOCs) that are emitted into the atmosphere during biomass burning and form through aqueous phase reactions of carbonyl compounds with ammonium species. Recent studies have identified the presence of IMs at various atmospheric sampling sites. However, once these compounds are formed, few studies have reported the further atmospheric processing of IMs. The vapor pressure of pure SVOCs and the volatility of internally mixed SVOCs with inorganic salts can govern the gas-particle partitioning and influence the atmospheric processing of IMs.

In this work, we characterize the vapor pressure of IM, 4-methylimidazole (MeIM) and imidazole-2-carboxyaldehyde and explore the effect of co-solutes on the volatility and lifetime of the particles, using particles levitated in a linear-quadrupole electrodynamic balance coupled with Mie resonance spectroscopy. We estimate pure component liquid phase vapor pressures of these compounds through measurements of evaporation of binary particles at elevated humidity, under the assumption of an ideal solution. We then show that while these compounds evaporate rapidly from pure states, when present in internal mixtures with ammonium salts, they are significantly stabilized in the particle phase. In such ternary particles, we measure two distinct phases of evaporation characterized by fast and slow changes. We analyze these regions separately, allowing the evolving composition of the particle to be determined from an evaporation model and identifying the characteristic composition at which stabilization occurs. At elevated RH, water contributes to the stabilizing effect, allowing particles to persist for much longer than expected based on pure component vapor pressures alone.

Interestingly, under dry humidity, we observe that the presence of ammonium chloride in MeIM particles with mole fraction ≤0.5, causes very slow evaporation of MeIM, resulting in about 48 hrs residence time of MeIM in particle, whereas pure MeIM particle evaporates in few minutes. Based on theoretical studies reported in the literature, ion-molecule interactions stabilize IM due to the formation of hydrogen bonds between the protons of ammonium with the lone pair of the nitrogen atom of IMs. Overall, this work highlights the importance of considering co-solutes and their stabilizing effect on semi-volatile components, with important implications for understanding and predicting the composition of biomass burning aerosol particles.

6AP.1

A Comprehensive Analysis of New Particle Formation Across the Northwest Atlantic: Analysis of ACTIVATE Airborne Data.

SOODABEH NAMDARI, Taiwo Ajayi, Yonghoon Choi, Ewan Crosbie, Josh DiGangi, Glenn Diskin, Simon Kirschler, Hongyu Liu, John Nowak, Michael Shook, Cassidy Soloff, Kenneth Thornhill, Christiane Voigt, Edward Winstead, Bo Zhang, Luke Ziemba, Armin Sorooshian, *University of Arizona*

New particle formation (NPF) is a critical source of particles and cloud condensation nuclei, yet there are scarce vertically-resolved measurements addressing NPF across different seasons in marine regions. This study leverages a multi-season set of airborne data from the NASA ACTIVATE mission between 2020-2022 to examine NPF characteristics over the northwest Atlantic ranging from the polluted U.S. East Coast to as far downwind (>1000 km) as Bermuda. Using the number concentration ratio above 3 and 10 nm (N3:N10) as a NPF indicator, we observe the highest ratios in the coldest months and comparable ratios over Bermuda relative to the U.S. East Coast. Within seasons, the highest and lowest ratios are found immediately above cloud tops and at the lowest possible flight altitudes (~ 150 m above sea level), respectively. The ratio of (N3-N10)/N3 ranges from 0.16-0.29 depending on altitude, proximity to clouds, and season. The N3:N10 and (N3-N10)/N3 ratios increase with altitude up to as high as 9 km, with a case study showing favorable conditions around relatively thicker and precipitating cloud systems presumably due to high actinic fluxes and reduced aerosol surface area. Regression modeling reveals that increased N3:N10 is influenced most by reductions in temperature, relative humidity, and aerosol surface area. This work emphasizes the importance of both NPF in remote marine regions like Bermuda and vertical heterogeneity that exists in its contribution to aerosol and cloud condensation nuclei number budgets.

6AP.2

High Resolution Investigations into Non-Ideal Resuspension Phenomena.

EDWARD NEAL, Barnaby Miles, Lukesh Mahato, Richard J. Thomas, Maurice Walker, Jack Vincent, Simon Parker, Virginia Foot, Emily Kruger, Jonathan P. Reid, *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 research explores two scenarios that can influence resuspension rates, non-spherical particle morphologies and particle-particle collisions, utilizing wind tunnel studies at 100 frames per second (FPS) and high frame rate imaging at 30000 FPS to explore collective and single particle resuspension events.

A novel methodology (Neal et al., Submitted 2024) is employed to investigate the impact of particle-specific features on resuspension, partnering a quadrupole electrodynamic trap for controlled particle fabrication and deposition (the QuadFab) with a small-scale 3D printed wind tunnel. Within the QuadFab, aerosol droplets are suspended and dried under controlled relative humidity (RH) conditions. Varying this RH adapts the morphology of the resulting particles that are subsequently deposited and resuspended in the wind tunnel. Resuspension efficiencies for two morphologies of sodium chloride particles, exhibiting raspberry-shaped and cubic morphologies, will be presented. The difference between the resuspension of these morphologies is further explored with high frame rate imaging of individual resuspension events. This technique allows for greater resolution analysis of particle orientation, particle-surface contact and rotation during resuspension.

Finally, during validation experiments with spherical glass standards the tendency for particles to collide and produce cascading resuspension events was identified as a potential source of increased resuspension (Neal et al., Submitted 2024). A collision-focused analysis of these glass standard resuspensions is now presented that evaluates collision angles and distances, benefiting from the high temporal resolution of the wind tunnel apparatus. By probing both morphology and collision related phenomena this research aims to increasingly untangle the complex mixture of factors that contribute to particle resuspension.

6AP.3

Modeling Aerosol Deposition Mechanisms in Spent Nuclear Fuel Dry Storage Casks Using MATLAB and Simulink. JAMES HENRY, Ren Garity, Andrew Metcalf, John Saylor, *Clemson University*

Concerns regarding the safety and integrity of spent nuclear fuel (SNF) dry storage casks (DSCs) influence the need for further investigation of the various aerosol deposition mechanisms that lead to corrosion or other potential cask degradations. Some atmospheric aerosols, especially sea salt aerosols, can deposit along weld seams or other areas of surface irregularity, leading to an increased risk for stress corrosion cracking (SCC). Thus, the need for accurate models to predict expected deposition zones and corresponding areas of degradation is imperative.

Aerosol deposition depends on several factors, including ambient temperature, relative humidity, air velocity, and particle size. In the case of SNF DSCs, convection-driven airflow within specific design geometries dictates where aerosol deposition is likely to occur. In this work, we develop a user-friendly aerosol deposition model that considers specific environmental conditions and air duct geometry.

The Mathworks® suite of products offers opportunities to model these various aerosol deposition mechanisms, specifically the MATLAB and Simulink programs. Through the use of empirically derived aerosol physics calculations, we have developed a MATLAB- and Simulink-based aerosol modeling application, Aerosol Calculator Application for Theoretical Modeling (AeroCATm), to understand the deposition behavior in SNF DSCs. The application can also be used for more general applications to model aerosol deposition for a given set of environmental conditions and in various flow geometries.

6AP.4

Environmental Factors Driving Sea Spray Aerosolization-- A Laboratory-Scale Breaking Wave Case Study. RAYMOND LEIBENSPERGER III, Kimberly Prather, Grant B. Deane, M. Dale Stokes, Christopher Lee, Meinrat O. Andreae, Jena Herbst, Justin Hamlin, Ke' La Kimble, Charbel Harb, Greg Sandstrom, Joseph Mayer, Rob Klidy, Eric Pham, Elizabeth Pogue, *University of California San Diego*

Sea spray aerosols (SSA) are among the most ubiquitous naturally produced aerosols on the planet and drive our climate through poorly constrained aerosol-cloud interactions. Despite the air-sea interface being investigated for over half of a century, the complex air-sea interface is difficult to characterize in situ, leading to large variance in literature estimates. To combat this, the new Scripps Ocean-Atmosphere Research Simulator (SOARS) wind-wave channel enables unprecedented control of environmental variables, allowing for high-fidelity studies of SSA emissions. Here, we briefly detail three experiments working to understand environmental drivers independent of one another. First, we used heavily filtered seawater to investigate the impact of wind speed on SSA. Then seawater inoculated with locally-sourced phytoplankton allowed us to investigate the impact of a mesocosm on SSA production. Finally, heavily filtered seawater underwent a large change in temperature (2 to 23ºC) to elucidate the impact of temperature on SSA. It was found that wind speed non-linearly increased SSA emissions, necessitating more studies covering a range of wind speeds from the global average (around 6 $m s^{-1}$) to storm conditions in the Southern Ocean (exceeding 20 $m s^{-1}$). Agreeing with previous work in wave channels, biological activity did not have a statistically significant effect on SSA emissions under low or high wind conditions. Interestingly, temperature was found to be inversely related to sea spray aerosolization, which is one of the least studied influences in literature despite being a key driver in climate models. These environmental drivers are not concisely characterized in the literature, so these results together offer a state-of-the-art comprehensive exploration into SSA production in a realistic breaking wave proxy. While there is still large variability to be accounted for by mixing these factors, these results further constrain SSA flux estimates, enabling model parameterization updates, potentially improving model performance.

6AP.5

Bubble Related Spray Aerosol Production. XIAOFEI WANG, *Fudan University*

Bubble bursting on water surfaces is believed to be a main mechanism to produce submicron drops, including sea spray aerosols, which play a critical role in forming cloud and transferring various biological and chemical substances from water to the air. Over the past century, drops production mechanisms from bubble bursting have been extensively studied. They usually involve the centrifugal fragmentation of liquid ligaments from the bubble cap during film rupture, the flapping of the cap film, and the disintegration of Worthington jets after cavity collapse. Here, we show that a dominant fraction of previously identified as “bubble bursting” submicron drops are in fact generated via a new mechanism underwater, inside the bubbles themselves before they have reached the surface. These drops are then carried within the rising bubbles towards the water surface and are released in air at bubble bursting. Evidence suggests that these drops originate from the flapping instability of the film squeezed between underwater colliding bubbles. This finding fundamentally reshapes our understanding of sea spray aerosol production and establishes a new role for underwater bubble collisions regarding the nature of transfers through water-air interfaces.

6AP.6

Particle Size Distribution Based on Mass and Number Count of Undiluted E-Cigarette Aerosols at Low Actuation Powers. MOHAMMAD SHAJID RAHMAN, Edgar Matida, Tarik Kaya, *Carleton University*

Electronic cigarette (e-cigarette) produces inhalable aerosols by heating a liquid mixture (known as e-liquid) using battery power. Since inhaled aerosols with different sizes deposit on different regions of respiratory tract, particle size distribution (PSD) of e-cigarette aerosols demands thorough investigation to evaluate associated health hazards. Due to different limitations of measuring devices, aerosols are often diluted with air, while the PSD can be affected by the dilution process. Besides, a low heating power (e.g., less than 10 W) of e-cigarette can be beneficial in terms of a lesser production of toxic elements. However, PSD of undiluted e-cigarette aerosols at lower powers with a standard testing condition is deficient in literature. This study reports PSD of undiluted aerosols generated by a modern e-cigarette at low powers ranging from 3.5 to 6.5 W with a standard puffing topography (i.e., puff duration and flow rate of about 3 s and 1 L/min, respectively). A low-flow cascade impactor (In-Tox, 02-007) and a real-time particle counter (PSD 3603, TSI) were used to measure PSD based on mass and number count, respectively. Gravimetric measurement of PSD revealed a re-distribution of particle size towards larger particles with higher power. PSD based on particle count depicted that asymmetricity in PSD became more pronounced with power. A novel mathematical equation (a combination of exponential, Gaussian and polynomial functions) was introduced to express a wide range of asymmetric PSD. Mass median aerodynamic diameter (MMAD), count median aerodynamic diameter (CMAD) and geometric standard deviations, estimated by the two measuring methods, were compared. The values of MMAD and CMAD were within a range of 0.71 to 0.89 µm and 0.67 to 0.73 µm, respectively, when power increased from 3.5 to 6.5 W. The undiluted PSD data can be utilized in dosimetry modeling along with design improvements of related aerosol generating devices.

6AP.7

Understanding Marine Boundary Layer Aerosol Number Budget Using Airborne Flux Measurement.

AJMAL RASHEEDA SATHEESH, Nicholas Meskhidze, Markus Petters, *North Carolina State University*

Quantifying the vertical distribution of aerosol over marine regions is crucial, as aerosol-cloud interaction in clean environments represents large uncertainty in radiative forcing calculations. Measurements of aerosol vertical distribution over oceans remain limited, and the relative contribution of different sources (sea spray, long-range transported anthropogenic pollution, new particle formation) to the aerosol and Cloud Condensation Nuclei (CCN) number budget in the Marine Boundary Layer (MBL) is poorly quantified.

The Azores archipelago provides a unique opportunity to study the MBL aerosol and CCN number budgets, as it represents a remote marine environment with frequent aerosol intrusions due to long-range transport. This study utilizes data collected during the Aerosol and Cloud Experiments in the Eastern North Atlantic (ACE-ENA) field campaign. The submicron particle size distribution was retrieved during June-July 2017 and January-February 2018 airborne measurements using a fast integrated mobility spectrometer and passive cavity aerosol spectrometer and merged into a single size distribution product. Particle fluxes were calculated using the Eddy Covariance technique when the airplane was in its horizontal leg and out of clouds and precipitation events.

The presentation will show fluxes of 10-30 nm and 100-1000 nm particles for several case studies. High concentrations of 10-30 nm-sized particles in FT and the negative fluxes throughout the MBL were interpreted as nucleation events with subsequent entrainment of particles into the MBL during the flights on 6 July 2017 and 7 February 2018. Frequent positive fluxes of 100-1000 nm-sized particles were indicative of sea spray emission. These fluxes, along with measurements of meteorological variables and cloud microphysical properties, are used to quantify the contribution of a) the entrainment of freshly nucleated and long-range transported particles from the FT into the MBL, and b) sea spray flux to the aerosol and CCN number budgets.

6AP.8

Evaluation of Impacts of Haze Events on the Secondary Organic Aerosol Formation During the KORUS-AQ Campaign with CAMx-UNIPAR v1.4.

GANGHAN KIM, Myoseon Jang, Yujin Jo, Azad Madhu, *University of Florida*

Secondary Organic Aerosol (SOA) is a key component that forms the atmospheric organic particulate matter, affecting air quality associated with climate and human health. Despite the important aspect of SOA in air quality, SOA budgets in regional scales are still not well predicted because of missing precursors and the complexity of SOA formation mechanisms via multiphase reactions of various precursors under dynamic meteorological conditions. In particular, SOA simulations have been underpredicted during summer seasons under high humidity. Haze in urban areas is crucial because it can cause poor air quality due to the increased aqueous reaction of oxygenated organic products. In this study, the impact of the haze on SOA formation is simulated during the KORUS-AQ campaign in 2016 using the Unified Partitioning Aerosol-phase Reaction (UNIPAR) model in the Comprehensive Air quality Model with extensions (CAMx) platform. KORUS-AQ, an international cooperative air quality files study in South Korea, includes ground-based data and airborne data (NASA DC-8 and B-200 aircraft by NASA) to study the evolution of polluted cities (i.e., Seoul). In particular, the low-level transport/haze period appeared (24-31 May 2016) during KORUS-AQ, and significantly increased SOA formation. The UNIPAR model employed is capable of processing the multiphase reactions of precursors via multiphase partitioning of explicitly predicted oxygenated products and their reactions in organic and aqueous aerosol phases. The recently updated UNIPAR v1.4 employs model parameters to simulate SOA from 10 aromatics; naphthalene; and 3 biogenic for three major oxidation paths (OH radicals, ozone, and nitrate radicals) to process day and night SOA formation; and alkanes covering a wide range of carbon chain lengths (C9-C24) and branching ratios. For intermediate volatile precursors (long-chain alkanes), the chemical loss through a gas-particle partitioning process is considered. The CAMx-UNIPARv1.4 captures high SOA formation during the haze episode. The model predicts major SOA species, which are impacted by emission species, meteorological conditions (humidity, sunlight, and temperature), long-range transport, and day and night chemistry. The cities in South Korea are highly impacted by aromatic SOA followed by terpene and alkane while urban areas in the USA are affected by alkane and terpene as reported in the recent simulations for air quality in California and South USA. Isoprene SOA contributions were negligible during KORUS-AQ.

6CE.1 – INVITED

Electrical and Chemical Properties of Brake Wear Particles. JAMES SMITH, Adam Thomas, Paulus Bauer, Véronique Perraud, Lisa Wingen, Michelia Dam, Madeline Cooke, Barbara Finlayson-Pitts, *University of California, Irvine*

As the world transitions away from internal combustion engines, non-tailpipe sources such as tire and brake wear already rival tailpipes as a chief source of road transport emissions of PM2.5. The physicochemical properties of these particles are not well understood. This study focuses on measurements of the charge state of particles generated from disk brake wear. Experiments were performed using a unique brake dynamometer that applies constant torque to a constantly spinning brake rotor. This allowed for studies of gas and particle emissions under repeatable conditions of speed, position and torque, and temperature. We tested two types of brake pads used extensively in the US: ceramic and semi-metallic. A major finding of this project is that brake wear particles can be highly charged: up to 80% of particles emitted from ceramic brake pads possessed one or more charges. Measurements of charge state using tandem differential mobility analysis showed that, on average, charged brake wear particles hold 20-30 elementary charges for both pad formulations. With regards to the composition of ultrafine brake wear particles, organics, and some inorganics such as sulfates and nitrates, were probed in real time during these experiments using a thermal desorption chemical ionization mass spectrometer and off-line using liquid chromatography high-resolution Orbitrap mass spectrometry (LC-HRMS). Those measurements have shown that ultrafine brake wear particles emitted under harsh braking conditions are mostly organic, containing a complex mixture of unsaturated, oxygen and nitrogen-containing organic compounds.

6CE.2

Application of Mass Spectrometry Techniques to Study Tire Wear Particles and Associated Chemical Additives: From Laboratory Investigations to Field Studies. Xing Wang, Michael A.R. Tawadrous, Bonnie Hamilton, Chelsea Rochman, Colman Wong, Yushan Su, Greg J. Evans, Arthur W. H. Chan, ALEX K.Y. LEE, *Environment and Climate Change Canada*

Non-exhaust vehicular emissions are increasingly important as a source of air pollutants. Abrasion of vehicle tires can generate airborne particulate matter, but the chemical characterization has been limited. In this work, we aim to develop online and offline mass spectrometry techniques to study the chemical composition of tire wear particles, in order to quantify their contribution to near-road air pollution and investigate the fate and transformation of tire additives.

In our laboratory investigation, a soot particle aerosol mass spectrometer (SP-AMS) was used to study tire wear particles generated by grinding old tire treads. The mass spectra of such airborne tire wear particles resemble those of tire tread rubbers measured by pyrolysis gas chromatography-mass spectrometry (Py-GC/MS) and hydrocarbon-like organic aerosols (HOA) that are largely associated with traffic activities. Carbon blacks are widely used as reinforcing fillers in tires, and they can be found in road dust with tire rubber. Nevertheless, no detectable amounts of refractory black carbon (rBC) signals were observed during the laser vaporization mode of SP-AMS measurement, suggesting that carbon blacks were unlikely co-emitted with tire nano-rubber into the air in our experiments. This work also developed a workflow incorporating microwave assisted extraction into Py-GC/MS analysis to identify the polymeric composition and tire additives (e.g. antioxidants) in tire tread. Levels of chemical additives in tire wear debris are highly variable, while the rubber content varies by a factor of 1-2. Applying Py-GC/MS analysis to measure the rubber contents in air samples adjacent to a busy highway, we estimate the contribution of tire wear particles to total suspended particles and survey the dynamics of chemical additives in the near road environment.

6CE.3

Characterization of Secondary Organic Aerosol Formation from Brake Emissions. MADELINE COOKE, Adam Thomas, Véronique Perraud, Lisa Wingen, Lena Gerritz, Berenice Rojas, Paulus Bauer, Barbara Finlayson-Pitts, James Smith, *University of California, Irvine*

Traffic emissions are a main source of particulate matter (PM) in urban environments, comprising two categories: exhaust emissions, generated from combustion in the tailpipe, and non-tailpipe emissions, generated mainly from brake and tire wear. With the national trend toward replacing combustion vehicles with electric, exhaust emissions are currently trending downwards and non-tailpipe emissions are rising in importance. Thus far, studies on brake wear have focused on primary emissions, demonstrating that braking generates PM with organic content across a wide size range, including fine and ultrafine particles. While understanding of primary brake emissions has advanced, the potential for brake emissions to undergo atmospheric oxidation and form secondary organic aerosol (SOA) has not yet been explored. In addition to PM, primary brake emissions contain organic and inorganic gases of various volatility that will be reactive in air. Herein, we investigate SOA formation from both gas and particle-phase brake emissions after reaction with ozone (O_3). Through controlled chamber experiments coupled to our unique custom-built dynamometer, we investigate the reactivity of gaseous brake emissions from two common brake pads (ceramic and semi-metallic) with O_3 and show that oxidation results in the nucleation of secondary ultrafine particles. Furthermore, gas-phase measurements indicate that emitted organic gases react with O_3, which could lead to the formation of low volatility organic gases and explain the observed nucleation. In addition, we compare the composition of organic species in PM from brake emissions before and after O_3 oxidation utilizing ultrahigh performance liquid chromatography combined with high-resolution Orbitrap mass spectrometry. We observe that the organic fraction in PM is dominated by CHO and CHON species. Several particulate species are reactive with O3, decreasing in abundance after O3 exposure. Our results can be applied to better predict how non-tailpipe emissions will impact urban air quality and to mitigate their effects moving forward.

6CE.4

Investigation of VOC Emissions and Retention from Wildland Urban Interface Fires. WILLIAM DRESSER, Shantanu Jathar, Christian L'Orange, Joost A. de Gouw, *University of Colorado*

Wildfires at the wildland-urban interface(WUI) have been increasing over recent decades with the expansion of human development. These fires present a unique set of concerns around the potential production and exposure to novel chemical compounds not traditionally found in biomass fires since the fuel composition includes large amounts of structural materials such as insulation, siding, and plastics. What these structural emissions look like is not as well understood as biomass emissions and important as WUI fire range expands. Additionally, the acute exposure to smoke can not only occur during the event but the proximity of WUI fires to structures means a greater amount of emissions infiltration into indoor air. Enhanced indoor concentrations can then potentially persist due to high surface-to-volume ratios and low air exchange rates. The work presented here focuses on understanding these issues with studies in the laboratory and field focused on measurements of volatile organic compounds (VOCs) using Proton-Transfer-Reaction Time-of-Flight Mass Spectrometer (PTR-TOF-MS). VOCs are of concern for their health risks and potential to form secondary organic aerosols (SOA).

Laboratory measurements were made as part of the Burning Homes and Structural MAterial (BHASMA) study at Colorado State University. Real-time data was collected over multiple burns noting differences in emission profiles over time as well as distinct emission profiles between materials. Field measurements focused on indoor measurements after the Marshall Fire in 2022. Indoor measurements were begun in smoke impacted homes quickly after the fire and lasted for roughly a month following the event allowing for long term analysis of indoor VOC concentrations. The persistence of VOCs was then compared to past work around surface partitioning and indoor studies to better understand the exposure to and evolution of indoor compounds.

6CE.5

Multiphase Oxidation and Chlorination Chemistry Involving Biomass Burning-Related Compounds. DOUGLAS COLLINS, Lauren Stettler, Christina Clarke, Olivia Jaye, Ryan Ziskin, *Bucknell University*

Wildfires are affecting the air quality of increasingly wide swaths of continental regions, including highly populated areas. The transport of biomass burning smoke through the building envelope can be significant on a mass concentration basis, especially during episodes that exhibit extreme outdoor particulate mass concentrations. This presentation will describe a variety of multiphase chemistry studies aimed at understanding chemistry that may occur within biomass burning aerosol particles and on surfaces that have been contaminated with such aerosol through dry deposition. Many indoor activities can generate significant concentrations (100s of ppb) of reactive trace gases that are known to react with organic surfaces. We will highlight our studies of certain multiphase oxidation and/or chlorination reactions under exposure to gaseous hypochlorous acid (HOCl) and chlorine (Cl_2). Our studies document, through both targeted and non-targeted analysis with high-resolution mass spectrometry, important chemical effects associated with varying trace gas exposure, surface film composition, and ambient light levels. A focus will be placed on inspecting the de novo formation of chemical products of potential toxicological concern detected in the condensed and/or gaseous phases.

6CE.6

Mechanistic Insights into Radical Formation during the Photochemical Aging of Biomass Burning Secondary Organic Aerosols. LENA GERRITZ, Sergey Nizkorodov, Manabu Shiraiwa, *University of California, Irvine*

The photochemical aging of atmospheric aerosols alters its physical and chemical composition, which may have important implications on the toxicity and climate effects of these particles. Recent work has explored the impact of photochemical aging on particle composition, but there is limited understanding on the molecular-level processes occurring. This study applies electron paramagnetic resonance (EPR) spectroscopy with a spin trapping agent BMPO and high-resolution mass spectrometry (HRMS) to study the formation of reactive oxygen species (ROS) and free radicals during the irradiation of lab generated secondary organic aerosol (SOA). This work compiles the radical formation in SOA derived from terpenes (α-pinene, α -terpineol, β-ocimene, isoprene), phenyl derivatives (phenol, styrene, toluene, guaiacylacetone) and furfural to provide insight into the aging mechanisms for different classes of SOA precursors prominent in biomass burning emissions. EPR analysis reveals that terpene SOA produced the most radicals including $HO_2\cdot$, carbon centered organic radicals ($R\cdot$), and oxygen centered organic radicals ($RO\cdot$). The HRMS identification of the organic radicals correspond to common products of Norrish Type I photolysis of carbonyls, and mechanisms for the photolysis of α-pinene SOA are proposed. Phenyl derivatives produced significantly lower SOA mass and fewer radicals including only $HO_2\cdot$ and $R\cdot$. The EPR results suggest photosensitized phenyl derivative SOA reacts via single electron transfer reactions with dissolved oxygen to produce superoxide and phenoxy radicals. HRMS analysis identified other types of radicals formed during photolysis, suggesting the contribution of additional photosensitized mechanisms. This presentation will summarize a comprehensive series of experiments on the potential mechanisms involved in the photochemical aging of SOA, which can help inform large-scale models and assess the evolution of chemical, physical, and toxicological properties of SOA throughout its atmospheric lifetime.

6CE.7

Modeling Novel Aqueous Particle and Cloud Chemistry Processes of Biomass Burning Phenols Forming Secondary Organic Aerosol.

MANISHKUMAR SHRIVASTAVA, Jie Zhang, Lan Ma, Wenqing Jiang, Cort Anastasio, Qi Zhang, Alla Zelenyuk, *Pacific Northwest National Laboratory*

Phenols emitted from biomass burning contribute significantly to secondary organic aerosol (SOA) formation through the partitioning of semi-volatile products formed from gas-phase chemistry and multiphase chemistry in aerosol liquid water and clouds. The aqueous-phase SOA (aqSOA) formed via hydroxyl radical (•OH), singlet molecular oxygen (1O2*), and triplet excited states of organic compounds (3C*), which oxidize dissolved phenols in the aqueous phase, might play a significant role in the evolution of organic aerosol (OA). However, a quantitative and predictive understanding of aqSOA has been challenging. Here, we develop a stand-alone box model to investigate the formation of SOA from gas-phase •OH chemistry and aqSOA formed by dissolution of phenols followed by their aqueous-phase reactions with ·OH, 1O2*, and 3C* in cloud droplets and aerosol liquid water. For the same initial precursor organic gas that dissolves in aerosol/cloud liquid water and subsequently reacts with aqueous phase oxidants, we predict that the aqSOA formation potential (defined as aqSOA formed per unit dissolved organic gas concentration) of guaiacyl acetone (GA, a highly water soluble and reactive phenol) is higher than that of isoprene-epoxydiol (IEPOX), a well-known aqSOA precursor. Cloud droplets can dissolve a broader range of soluble phenols compared to aqueous aerosols, since the liquid water contents of aerosols are orders of magnitude smaller than cloud droplets. Our simulations suggest that highly soluble and reactive multifunctional phenols like GA would predominantly undergo cloud chemistry within cloud layers, while gas-phase chemistry is likely to be more important for less soluble phenols. But in the absence of clouds, the condensation of low-volatility products from gas-phase oxidation followed by their reversible partitioning to organic aerosols dominates SOA formation, while the SOA formed through aqueous aerosol chemistry increases with relative humidity (RH), approaching 40% of the sum of gas+aqueous aerosol chemistry at 95% RH for GA. Our model developments of biomass-burning phenols and their aqueous chemistry can be readily implemented in regional and global atmospheric chemistry models to investigate the aqueous aerosol and cloud chemistry interactions of biomass-burning organic gases in the atmosphere.

6CT.1 – INVITED

Understanding Aerosol Fluxes: Recent Observations and Insights into Particle Emission and Deposition.

DELPHINE K. FARMER, Rutambhara Joshi, Roman Liedtke, Lillian Jones, Erin K. Boedicker, *Colorado State University*

The lifetime of aerosol particles in the atmosphere is driven by removal processes. While wet deposition is often considered the driver of atmospheric removal of particles, dry deposition can play a substantial role for particles of different size ranges and in different regions of the planet. Few observational constraints of aerosol dry deposition exist, limiting model validation and development. To this end, we have conducted intensive size-resolved particle flux measurement campaigns over both grasslands and the low Arctic tundra using optical particle detectors coupled to sonic anemometers for eddy covariance flux analysis. We also have developed a smaller version of this eddy covariance flux approach for deployment at longer-term (months-long) measurement campaigns over multiple land surface types through the Fluxes of AerosoL Continuous Observing Network (FALCON). These sites include a marine site (Scripps Pier, CA as part of the EPCAPE project), a grassland site (Southern Great Plains, OK), a deciduous forest (Chestnut Ridge, TN), and additional sites as available. We are using these studies to investigate drives of particle deposition. However, upward fluxes of particles are consistently observed during particle flux measurements. To investigate the hypothesis that bioaerosol can contribute to these fluxes through emissions, we are investigating fluxes of particulate DNA over a grassland site alongside the size-resolved particle flux measurements.

6CT.2

Progress and Updates on Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT): Advanced, Ground-based Aerosol Measurement Network Across the U.S. NGA LEE NG, Roya Bahreini, Ann M. Dillner, 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, *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 across the country, leveraging existing monitoring locations and facilities. Each site is equipped with a suite of advanced aerosol instrumentation, including an Aerosol Chemical Speciation Monitor (ACSM, non-refractory aerosols), 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). All the 12 sites have been established and are operational. We continue to develop standard operational procedures (SOP) for data analysis, automated QC checks for basic level data, and data import. We also conduct comprehensive intercomparisons to evaluate instrument performance. For each site, measurements from ASCENT instruments are compared against each other and with collocated measurements from other monitoring networks, including PM2.5 measurements and offline filter sample data. We will provide an overview of the measurement results from all 12 sites, highlighting similarities and differences in aerosol chemical composition and characteristics across urban, rural, and remote sites. These high time-resolution measurements also provide an unparalleled capability in studying aerosol dynamics and transformation. Results from specific events (e.g., wildfires, fireworks, etc.) will be presented for selected sites. We welcome collaborative opportunities leveraging the ASCENT infrastructure to advance our understanding of aerosol sources and characteristics and their impacts on air quality, climate, and health.

6CT.3

Year-long Measurements of Aerosol Composition and Size Distributions at the ASCENT- Rubidoux Site. ROYA BAHREINI, Bradley Ries, Yumeng Cui, Erin Bowey, Sean Raffuse, Sabrina Westgate, Armistead G. Russell, Ann M. Dillner, Nga Lee Ng, *University of California, Riverside*

Through the Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT), funded by the National Science Foundation, 12 sites have been established across the United States to provide comprehensive, high time-resolution measurements of aerosol composition and size distributions. One of the sites is located in Rubidoux, CA which is downwind of major urban and industrial sources in the Los Angeles Basin. In addition to the main ASCENT instrumentation, namely an Aerosol Chemical Speciation Monitor (ACSM, $PM_{2.5}$, Aerodyne Research Inc.), an aethalometer (AE33, $PM_{2.5}$, Magee Scientific), an XRF-based trace metal monitor (Xact-625i, $PM_{2.5}$, Sailbri Cooper, Inc.), and a scanning mobility particle sizer (SMPS 3839W89, TSI, Inc.), we have installed a Modulair-PM sensor (QuantAQ) to obtain fast measurements of PM_1 and $PM_{2.5}$ mass concentrations. Furthermore, the South Coast Air Quality Management District provides online measurements of several air pollutants (including $PM_{2.5}$ mass concentration, O_3, CO, SO_2, NO_2, and total NMHC) and collects 24-hr integrated $PM_{2.5}$ filters (once every 3rd or 6th day) for offline chemical analysis. Here we report on the first set of long-term comparisons between the data collected through ASCENT and those available externally to demonstrate the performance of ASCENT instruments at this site. Furthermore, we present diurnal and seasonal trends of aerosol composition and size distributions and highlight the main differences observed under specific conditions (e.g., 4th of July fireworks, wintertime inversions, and summertime high-ozone alert days).

6CT.4

First Year of Aerosol Characterization at the ASCENT-Atlanta Site: Temporal and Seasonal Variations of Aerosol Chemical Composition and Sources. RUIZHE LIU, Alison Fankhauser, Yutong Liang, David Pando, Roya Bahreini, Ann M. Dillner, Armistead G. Russell, Nga Lee Ng, *Georgia Institute of Technology*

Fine aerosol in the southeastern U.S. is often characterized by strong interactions of biogenic and anthropogenic emissions. Results from prior short intensive campaigns have shown that biogenic hydrocarbons contribute substantially to organic aerosol (OA) in the greater Atlanta area, especially in summer. However, seasonal variation of aerosol composition in Atlanta remains complex and poorly understood. In this work, we conduct continuous measurements at the South Dekalb site in Atlanta from April 2023 to May 2024, which is part of the Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT). A Time-of-Flight Aerosol Chemical Speciation Monitor (ToF-ACSM; non-refractory aerosol), an aethalometer (AE33; black carbon and brown carbon), an XRF-based trace metal monitor (Xact-625i; metals), and a Scanning Mobility Particle Sizer (SMPS, particle size distribution) are deployed. All instruments have a PM2.5 inlet except for SMPS which is PM1. We report temporal and seasonal variations of aerosol composition and sources from our first year of measurements. Overall, the data thus far show that fine aerosol is dominated by organics (72%), followed by black carbon (8%), sulfate and nitrate (6-7% each), ammonium and metals (3-4% each), and a negligible amount of chloride. Positive Matrix Factorization (PMF) analysis shows distinct OA subtypes and contributions. Less-oxidized and more-oxidized oxygenated OA (LO-OOA, MO-OOA) consistently display the highest mass concentrations across all seasons. The mass fractions of other factors exhibit seasonal variability, with primary OA such as cooking OA (COA), biomass burning (BBOA), and hydrocarbon-like OA (HOA) increasing in colder months. Potential sources of OOAs are investigated, including biomass burning, oxidation of biogenic hydrocarbons, and long-range transport. Lastly, we compare these ASCENT measurements with our decade long (2012-2022) intensive summer campaigns in Atlanta, showing how continued decreases in NOx and SO2 have impacted aerosol composition and sources in this region.

6CT.5

Characterizing the Sources of Aerosols and Volatile Organic Compounds (VOCs) Impacting Air Quality at the Denver ASCENT Site. SEONSIK YUN, Douglas A. Day, Anne V. Handschy, Erick Mattson, Abby Koss, Maya Abou-Ghanem, Joost A. de Gouw, Rainer M. Volkamer, Roya Bahreini, Ann M. Dillner, Armistead G. Russell, Nga Lee Ng, Jose-Luis Jimenez, *University of Colorado, Boulder*

Air pollution in the Denver metropolitan area has increased in recent years and is of concern due to its adverse effects on human health and regional visibility. Multiple sources likely contribute to this problem, including urban sources such as motor vehicles, industry, cooking, and volatile chemical products, regional sources such as agriculture, gas/oil extraction, biomass burning, and biogenic emissions, and continental background. Our understanding of the sources and their temporal variations in the Denver region remains insufficient, with information provided by field campaigns and routine air quality measurements of limited time resolution and chemical detail.

Since May 2023, we have deployed and operated several research-grade aerosol composition monitoring instruments in Denver as part of the new, long-term Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT), supported by the US National Science Foundation. The ASCENT network comprises 12 monitoring sites across the United States, with the primary objective of characterizing aerosol chemical composition, physical properties, and boundary layer dynamics continuously with a high time resolution. In conjunction with the ASCENT instruments, we utilized a Vocus Proton Transfer Reaction Time-of-Flight Mass Spectrometer (Vocus PTR-TOF) to measure volatile organic compounds (VOCs) during several weeks in Summer 2023 and Winter 2024.

Here, we present an analysis of the sources and chemical composition of aerosols and VOCs in Denver, focusing on the first year of data from the ASCENT site. The results include temporal variations of aerosols and VOCs over multiple timescales and comparisons to past field campaigns to investigate long-term trends. Additionally, Positive Matrix Factorization analysis is conducted to further characterize the sources of urban air pollutants, background sources, and long-range transport. Finally, ongoing analysis will employ wind and trajectory analysis to evaluate the relative contributions of different emission sources in Denver and potential relationships with aerosol, VOC species, and other trace gases.

6CT.6

From TexAQS 2000 to ASCENT: The Evolution of Sources and Chemical Compositions of Nonrefractory Submicron Particles Based on Surface Aerosol Mass Spectrometry Measurements in Houston, Texas. FANGZHOU GUO, Robert Griffin, Manjula Canagaratna, Subin Yoon, Chun-Ying Chao, James Flynn, Barry Lefer, Shan Zhou, Luke Ziemba, Henry Wallace, Qili Dai, Benjamin Schulze, Roya Bahreini, Ann M. Dillner, Armistead G. Russell, Nga Lee Ng, Scott Herndon, *Aerodyne Research, Inc.*

The Houston-Galveston-Brazoria (HGB) area historically has been subject to significant air pollution, with abundant emissions of highly reactive VOCs, NO_X, and SO_2 from local and regional sources including mobile sources, the petrochemical industry, and shipping emissions. The strong solar radiation, high ambient temperature and humidity, and seasonal inflow of airmasses from the Gulf of Mexico further complicate the conditions favorable for secondary aerosol and ozone formation, imposing a direct health threat to 2.3 million people.

Ever since their first deployment in the HGB area in Texas Air Quality Studies (TexAQS) in 2000, Aerodyne aerosol mass spectrometry instruments measured nonrefractory submicron particles through intermittent, intensive campaigns including TexAQS (2000), TexAQS-II (2006), DISCOVER-AQ (2013), HACHE and BEETEX (2014-2016), TRACER-MAP and TRACER-AQ2 (2022) and from continuous sampling at a suburban site since April 2024 as part of the ASCENT network.

Data from multiple quadrupole (Q-) and high-resolution time-of-flight (HR-ToF-) aerosol mass spectrometers (AMS) and aerosol chemical speciation monitors (ToF-ACSM) are reviewed (2000-2016), analyzed (2022-2024), and systematically evaluated with ancillary measurements to characterize the evolution of submicron aerosols in the HGB area over the past approximately 25 years. Preliminary findings indicate that the dominant contributors to NR-PM_1 mass are organics (47%-64%) and sulfate (24-44%). Total NR-PM_1 loadings (µg/m3) remain relatively stable across the urban core (12.8 (summer 2000), 11.0 (summer 2006), 9.7 (summer 2013), 10.8 (winter 2015), and 13.1 (summer 2022)). However, strong spatial variations are observed in peripheral urban-suburban mixed areas such as Conroe (11.6 (summer 2013)), Sugar Land (4.0 (summer 2014)), Galveston (4.7 (summer 2016)), and Liberty (9.1 (summer 2024)). Results from positive matrix factorization also reveal drastically changing sources of summer organic aerosol at the urban core, with POA/SOA ratio decreasing from 0.82 (summer 2000) and 0.75 (summer 2006) to 0.23 (summer 2013) and 0.12 (summer 2022).

6CT.7

Ambient Particulate Metals and Their Sources at the Los Angeles ASCENT Site. HAROULA D. BALIAKA, Ryan X. Ward, Sina Hasheminassab, Paul Wennberg, Roya Bahreini, Ann M. Dillner, Armistead G. Russell, Nga Lee Ng, Richard Flagan, 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 topography promote the accumulation of anthropogenic and biogenic emissions, and, despite regulatory efforts, poor air quality persists. Ambient metals comprise about 5% of total particulates ($PM_{2.5}$) and are an important category of hazardous air pollutants with known detrimental impacts on human health. With direct tailpipe emissions from vehicles in California improving, attention has shifted towards brake and tire wear particulate matter as one of the dominating sources of traffic-related emissions. In this work, we conduct field measurements at an urban site in Pico Rivera, in Los Angeles County, CA that is in close proximity to a dense cluster of metal processing facilities located in East/Southeast LA. 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. An Aerosol Chemical Speciation Monitor (ACSM) measures the composition and mass concentration of the non-refractory aerosols, an Xact monitors trace elements, an Aethalometer measures black and brown carbon, and a Scanning Mobility Particle Sizer (SMPS) is used for the aerosol number size distribution. Here, we present results on the temporal (i.e., diurnal, day-of-the-week, seasonal) trends in the measured $PM_{2.5}$-bound metals derived from the Xact instrument. We compare with other studies measuring total suspended particulate metals and explore the effect of coarser vs fine particles. Lastly, we perform Positive Matrix Factorization (EPA v 5.0) source apportionment analysis on the ACSM and multi-metals data as well as complimentary measurements and identify major sources associated with road dust, industrial emissions, and brake wear.

6CT.8

Real-Time Characterization of Fine Aerosol Composition during the First Year of Continuous Operation at the Look Rock, TN ASCENT Site. NICOLAS ALIAGA BUCHENAU, Cade Christensen, James Renfro, Bill Hicks, Roya Bahreini, Ann M. Dillner, Armistead G. Russell, Nga Lee Ng, Jason Surratt, *University of North Carolina at Chapel Hill*

A near yearlong (2023-2024) real-time chemical characterization of fine aerosol (PM2.5) was conducted as part of the Atmospheric Science and Chemistry Measurement Network (ASCENT) at the Look Rock, TN site in Great Smoky Mountains National Park, which serves as the network's rural, background site in the Southeastern United States. A Time-of-Flight Aerosol Chemical Speciation Monitor (ToF-ACSM, Aerodyne Research, Inc.) was used to provide real-time composition measurements of non-refractory fine aerosol, allowing us to conduct positive matrix factorization for identifying distinct organic aerosol components indicative of varying sources and atmospheric chemical processes. Fine aerosol characterization was assisted by the colocation of other ASCENT instruments: an AE33 aethalometer (Aerosol Magee Scientific) and Xact 652i (Sailbri Cooper, Inc.) for near real-time black carbon and metals measurements, respectively, and a 3839W89 Scanning Mobility Particle Sizer (TSI, Inc.) for near real-time fine aerosol size characterization. Fine aerosol composition measured during 2023-2024 will be compared against measurements and source apportionment results obtained from the 2013 field campaigns at Look Rock using a Quadrupole ACSM (Aerodyne Research, Inc.). The 2023-2024 PM2.5 aerosol composition is predominantly organic, and when compared to the 2013 PM1 baseline, demonstrates a substantial reduction (up to 70%) in particulate sulfate concentration, with average winter and spring sulfate declining to approximately ~0.4 µg m-3 and ~0.5 µg m-3, respectively. Potential implications of changing inorganic composition on organic aerosol components at Look Rock will be considered. The 2023-2024 dataset is additionally marked by the presence of several short-term high aerosol concentration events presumed to result from smoke plumes derived from sources such as local prescribed burning and the 2023 Canadian wildfires.

6HR.1

Impact of Wildfires on the Oxidative Potential of Ambient Aerosol. BRADLEY ISENOR, Arthur W. H. Chan, *University of Toronto*

Wildfire activity is predicted to increase over time, potentially increasing adverse health impacts due to elevated levels of fine particulate matter ($PM_{2.5}$). Elevated $PM_{2.5}$ attributed to wildfires pose a more serious problem when coupled with recent evidence that wildfire-$PM_{2.5}$ may be more toxic on a per mass basis than common forms of ambient $PM_{2.5}$ (*e.g.*, traffic and industrial $PM_{2.5}$). For these reasons, it is necessary that wildfire-$PM_{2.5}$ and their health effects are understood; however, few studies have directly assessed the potential toxicity of wildfire-$PM_{2.5}$. Here we study the toxicity of both wildfire and non-wildfire-$PM_{2.5}$ through the lens of their oxidative potentials (OP; *i.e.*, the ability to generate reactive oxygen species and induce oxidative stress). To assess the OP of our samples, we employ the dithiothreitol assay to measure antioxidant depletion. Alongside this assay, electron paramagnetic resonance spectroscopy is used with spin-trapping agents to identify and quantify harmful reactive oxygen species that may be generated when particulate deposits in the lungs. Ambient aerosol samples were collected at an urban site (Toronto, ON) and a remote site (East Trout Lake, SK) over 2023 with wildfire influence coming from the North American wildfires of that year. Given the location and separation of the 2 sites, they are predicted to have considerably different compositions and thus different OP due to differing sources and aging times of wildfire-$PM_{2.5}$. In this presentation, an analysis of OP data from samples that were collected at both sites will be presented with an emphasis on how the OP of $PM_{2.5}$ samples are impacted by elevated levels of biomass burning aerosol attributed to wildfires. Results from this work will improve understanding of how potential toxicity of PM is related to their sources and atmospheric evolution.

6HR.2

High Time Resolution Quantification of PM2.5 Oxidative Potential in London.

STEVEN CAMPBELL, Alexandre Barth, Ian (Gang) Chen, Anja Tremper, Max Priestman, David Ek, Markus Kalberer, David Green, *Imperial College London*

Exposure to airborne particulate matter (PM) has been attributed to a wide range of adverse health impacts and millions of premature deaths annually. Despite decades of compelling evidence from epidemiological and laboratory studies, the components of PM responsible for observed health effects remain unclear. Recent studies have widely suggested that oxidative potential (OP), defined as the capability of particles to catalytically produce reactive oxygen species (ROS) with subsequent depletion of antioxidants, is key to determining the health effects of PM exposure. However, accurate quantification of OP has somewhat been hindered by a lack of suitable measurement methods, as many chemical components contributing to OP are short-lived and in low ambient concentrations, posing a significant analytical-chemical challenge.

To overcome this issue, we have developed the online oxidative potential ascorbic acid instrument (OOPAAI), which utilises a direct-to-reagent sampling approach, impinging $PM_{2.5}$ into an ascorbic acid reagent within seconds, whilst also providing continuous, automated quantification of OP, with a time resolution of 5 minutes.

In this work, the OOPAAI was deployed in a series of ambient measurement campaigns for the first time - in an urban traffic monitoring station, adjacent to a heavily congested arterial route through central London for 3 months during Summer 2023, and at a rural background site for 2 months during Winter 2024. OP was quantified alongside a wide range of established air pollution measurements, including high time resolution elemental $PM_{2.5}$ composition (XRF, XACT 625i), non-refractory PM (aerosol chemical speciation monitor, ACSM), and black carbon (Aethalometer).

High time resolution measurements reveal the temporal dynamics of OP in London, with changes occurring on timescales of ~hours at the roadside site. This variability in OP was observed at average $PM_{2.5}$ mass concentrations of 7.1 ± 4.1 $\mu g\ m^{-3}$, below the World Health Organisation interim annual mean target of 10 $\mu g\ m^{-3}$. High time resolution composition measurements and source apportionment analysis reveals transient changes in $PM_{2.5}$ composition and sources such as break wear, emissions from London underground vents, wood burning, and firework activity are key drivers of OP. Determining the PM composition and sources that drive OP will help synthesise more targeted and effective air pollution mitigation strategies.

6HR.3

Chemical, Oxidative, and Toxicological Profiles of Fine Ambient Particulate Matter in Alaska.

OLUCHI NWEKE, P. S. Ganesh Subramanian, Sudheer Salana, Anastasia Hewitt, Raghu Betha, Vishal Verma, *University of Illinois, Urbana Champaign*

Oxidative potential (OP) is a metric that quantifies the ability of particulate matter (PM) to induce oxidative stress in humans and is widely used as a surrogate for PM toxicity. During winter, surface-based temperature inversions due to low solar insolation in Alaska, limits the dispersion of $PM_{2.5}$, predominantly emitted from residential wood-burning, and leads to higher ambient $PM_{2.5}$ concentrations. However, currently, there is limited research on the health effects and toxicological properties of Alaskan $PM_{2.5}$. In this study, we quantified the chemical composition and OP of $PM_{2.5}$ collected in the City of North Pole, Alaska during winter 2022–23 and compared them with wintertime $PM_{2.5}$ from the Midwest US. We evaluated the toxicity of $PM_{2.5}$ using four different metrics: 3 acellular OP endpoints — dithiothreitol (OP_{DTT}), glutathione (OP_{GSH}), and hydroxyl radical generation (OP_{OH}), and 1 cellular endpoint — cytotoxicity (CT) in A549 cells using crystal violet assay.

Our results revealed that wintertime ambient $PM_{2.5}$ concentrations in Alaska (39.1 $\mu g/m^3$) were 223.1% higher than Midwest USA (12.1 $\mu g/m^3$). The water-soluble and water-insoluble organic carbon (WSOC and WIOC) fractions in wintertime Alaskan $PM_{2.5}$ (17.0% and 13.3%, respectively) were 2 to 4 times that of Midwestern $PM_{2.5}$. However, the elemental carbon (EC) fractions in Alaska (3.2%) were similar to the Midwest. The average OP_{DTT}, OP_{GSH}, and OP_{OH} in Alaskan were 33.1±6.9, 18.7±6.4, and 0.14±0.12 pmol/(min.µg), respectively, translating to 1.68, 2.54, and 0.38 times of those reported for Midwestern $PM_{2.5}$. The average CT levels were also 60% higher in Alaska (2.68%/µg) compared to the Midwest (1.69%/µg). Strong intercorrelations ($r > 0.4$) were observed among the different endpoints, except between OP_{OH} and CT. Both OC and EC were strongly correlated ($r > 0.5$) with OP_{DTT}, OP_{GSH} and CT, but metals were not correlated ($r < 0.1$) with any of the OP assays. Collectively, these results indicate that the higher carbon fraction in Alaskan $PM_{2.5}$ may be driving its OP and could possibly explain the higher intrinsic OP in Alaska, as compared to the Midwest US, necessitating further research into the toxicological properties of air pollutants and subsequent health effects in Alaska.

6HR.4

Reactive Oxygen Species and Oxidative Potential of Outdoor and Indoor Particulate Matter in Wintertime Fairbanks, Alaska.

SUKRITI KAPUR, Kasey Edwards, Ting Fang, Meredith Schervish, Pascale Lakey, Yuhan Yang, Ellis Robinson, Peter F. DeCarlo, William Simpson, Rodney J. Weber, Manabu Shiraiwa, *University of California, Irvine*

Sub-arctic cities can face episodes of high air pollution during wintertime owing to extremely low temperatures and shallow surface-based inversion layer. During the ALPACA campaign in Fairbanks, Alaska in January – February 2022, we conducted sampling of outdoor fine particulate matter ($PM_{2.5}$) using a high-volume sampler and of indoor PM using a size-segregated cascade impactor in a house during activities including cooking and residential heating using a pellet stove. We measured environmentally persistent free radicals (EPFRs), stable organic radicals contained in PM, using electron paramagnetic resonance (EPR) spectroscopy. We also quantified the formation of reactive oxygen species (ROS) in water by EPR with a spin-trapping technique as well as PM oxidative potential (OP) using the dithiothreitol (OP-DTT) and OP-OH assays. We found good correlations of EPFRs with combustion and vehicular markers, indicating that residential wood stoves and traffic emissions may be major sources of EPFRs in Fairbanks. Outdoor PM mainly generates •OH (67%) and carbon-centered radicals (33%), while indoor PM forms predominantly •OH in water. Indoor submicron PM shows higher ROS and OP-DTT values compared to coarse PM. Both indoor and outdoor ROS exhibit little correlations with OP-DTT, indicating the need for additional analysis for the link between ROS and oxidative potential. Outdoor •OH also correlates well with water-soluble iron ($R^2 = 0.51$), indicating the role of Fenton or Fenton-like reactions in generating •OH in the aqueous phase. OP-OH correlates strongly with EPFRs and the modeled OH production rate in lung lining fluid correlates tightly with EPFRs, implying that EPFRs are redox active to generate •OH upon inhalation and respiratory deposition.

6HR.5

Air-borne Particulate Matter and Its Characteristics in the Indoor/Outdoor Environment of the Most Populated City of India.

JAMSON MASIH, Sachin Gupta, Lorraine Tellis, *Chemistry Department, Wilson College*

Present study focus on the characterization of the fine particulate matter in indoor and outdoor air. PM2.5 samples were collected from Nov 2022 to April 2023 indoor and outdoor air of domestic home of Mumbai, India. Twenty four hour >PM2.5, PM1.0 to PM2.5, PM0.50 to PM1.0, PM 0.25 to PM0.50, and < PM0.25 were collected on 25-mm PTFE filter paper using Sioutas Impactor with SKC Leland Legacy Sample Pump operated at 9 L/min. The sampled filters were digested in 6–8 ml HNO3 and kept on a hot plate at the temperature of 40–60 °C for 90 min, the solution was diluted with a known volume and analyzed on ICP-AES. The concentation of PM2.5 was found be higher in outdoor 102.22ug/m3 than indoors 115.61 ug/m3. The total contribution of analyzed metals in PM 2.5 was 60 to 70% in indoors and outdoors. The concentration trends of trace metals in indoor and outdoor was in the order Al>Fe>Zn>Pb>Cu>Mn>Cr>Ni. Al, Fe and Zn was found to be dominant and higher in indoor and outdoor air. The probable reason of being the higher Zn concentration in indoor and outdoor was due to automobiles such as lubricating oils and tires, while Al and Fe may arise from ressuspended dust. The sources of analyzed metals are house dust and anthropogenic activities indoors and another from infiltration from outdoors. Particulate matter were higher in the outdoor environment and below the permissible limit in indoor environment during the study period as recommended by Central Pollution Control Board and WHO. SEM-EDAX results showed flaky like appearance with the average size of 100 nm to 250 nm collected on a PTFE filter paper. Chemical composition of PM 2.5 and PM < 0.25 micron showed elements Cu, Al, Ca, K, Si, S and other metal ions. High concentration of Al and Si can be attributed to the presence of Aluminosilicates.The results of the present study are of practical importance in identifying sources and processes that control levels of fine particulate matter in a reparable size range. Further, the elemental constituents of reparable size range particulate matter are of public health interest, as it determines human susceptibility to pollution processes.

6HR.6

Impact of Gaseous Pollutants on the Incidence of Cardiovascular Diseases: A Case Study from Karachi, Pakistan. Haider Khwaja, OMOSEHIN MOYEBI, Zafar Fatmi, Azhar Siddique, Mirza M. Hussain, David Carpenter, *Wadsworth Center, University at Albany*

No prior studies exist in Karachi, Pakistan evaluating the short-term effect of ambient air pollution on cardiovascular diseases (CVDs). In this study, we adopted a generalized linear model to quantitatively analyze the influences of gaseous pollutants (NO, NO_2, O_3, SO_2, and HNO_3) on morbidity due to CVDs. Daily samples of gaseous pollutants were collected at an urban site in Karachi. Increased risk of morbidity due to CVDs including CVD subtypes [hypertension (HTN), ischemic heart disease (IHD), myocardial infarction (MI), congestive heart failure (CHF), and arrhythmias] with gaseous pollutants were observed to be significantly correlated. NO, O_3 and SO_2 exhibited strong significant associations with both total CVD and all the subtypes. Increase in NO caused a rise in total CVD at lag 1, 2, 3, and 5. O_3 and SO_2 showed a significant relationships to CVD hospital admissions (HAs) and emergency room visits (ER visits) at all the lag days (lag 0 – 5). Immediate effect was observed between NO and O_3 exposures with total CVD at lag 1 and 2, while SO_2 has a delayed effect at lags 3 and 4. NO_2 was significantly associated with total CVD on the day of exposure, while HNO_3 exhibited a statistically significant association with total CVD at lag 4. The largest significant effect for O_3 on arrhythmias was observed at the same day (RR= 1.20; 95%CI: 1.12 – 1.29). The gender, age, and seasonal significant association between pollutants and CVD did show differences in the magnitude. However, the risk of HAs and ER visits due to CVD was stronger among age-group 40 – 60. Exposure-response curve with NO and SO_2 was observed to have S-shaped relationship with CVD, while O_3 exhibited a J-shaped relationship with CVD. This confirmed that exposure to gaseous pollutants even at low concentrations can adversely impact the quality of life.

6HR.7

Adjoint Modeling of Spatially-Specific Health Benefits of PM2.5-related Controls and Linked Co-benefits from Greenhouse Gas Controls. Amir Hakami, Shunliu Zhao, Marjan Soltanzadeh, Petros Vasilakos, Burak Oztaner, Neal Fann, Howard Chang, Alan Krupnick, Anas Alhusban, ARMISTEAD G. RUSSELL, *Georgia Institute of Technology*

Adjoint modeling, using CMAQ, is performed to develop location-specific benefits from controls of primary $PM_{2.5}$ and $PM_{2.5}$ precursors across North America. Source-to-health benefit relationships are quantified using a benefit-per-ton (BPT) metric. BPTs are the valuations of premature mortality counts due to exposure to fine particulate matter resulting from emissions of one tonne of a pollutant (primary $PM_{2.5}$, NO_x, SO_2, and NH_3). Adjoint-calculated BPTs provide the differences and disparities in source impacts leading to a direct means for prioritizing and targeting emissions that are most damaging. Primary $PM_{2.5}$ and NH_3 emissions are found to have the largest BPTs, followed by SO_2, and NO_x. BPTs also can provide location-specific and sectoral estimates for co-benefits of reducing CO_2 emissions from a range of combustion sources. Calculations for various subsectors such as on-road transportation, thermal electricity generation, and off-road engines find that off-road engines and various heavy duty diesel vehicles exhibit the largest co-benefits in most urban locations, exceeding estimates of the social cost of carbon in those locations.

6HR.8

Modeling the Fukushima Daiichi Nuclear Disaster with QUIC-DEPDOSE. MATTHEW NELSON, John Klumpp, Diego Rojas Blanco, Liam Wedell, Sonali John, Chibuike Onwukwe, Sara Brambilla, Michael Brown, *Los Alamos National Laboratory*

By combining QUIC, an atmospheric plume dispersion application, with DEPDOSE, a respiratory tract deposition and dose calculation application capable of accounting for the sex, age, and activity level of individuals, QUIC-DEPDOSE calculates radiation doses to individual people from inhalation of radionuclides downwind from a radioactive plume. Following the earthquake and subsequent 15-meter tsunami on March 11, 2011, the local power grid and most of the backup power at the Fukushima Daiichi nuclear power plant failed, resulting in a loss of cooling for the nuclear reactors. The lack of cooling led to a nuclear disaster that unfolded over several days as the heat and pressure within various reactors built up. On March 12, the prime minister ordered an evacuation of all residences within 10 km of the plant and workers intentionally relieved the pressure building within the reactor to forestall the explosions which eventually occurred. The Futaba Hospital and Deauville Futaba retirement home located about 4.5 km from the plant were included in the evacuation. The evacuation of these facilities under these chaotic circumstances was difficult and was not completed until March 16. Tragically, moving medically fragile people resulted in the deaths of 45 patients. We use QUIC-DEPDOSE to simulate the intentional release of material from the plant under hypothetical winds to estimate the exposure that could have resulted to hospital staff and patients had the plume resulting from the intentional venting of the reactor passed over the hospital.

6PA.1 – INVITED

Lifting the Veil of Hazes on Planetary Atmospheres through Modeling and Observation. ERIC WOLF, *University of Colorado*

Aerosols of many flavors are common in our Solar System and are believed to be common across the Universe. Aerosols on Venus, Earth, Mars, Titan, Pluto, gas giants, and ice giants are well known, and recent observations hint at the ubiquity of clouds and hazes across the exoplanet population. Aerosols not only have significant effects on planetary climate through both direct and indirect radiative effects, they also have an outsized effect on observations. Notably, high altitude hazes obfuscate spectral signals, making detection and characterization of the gas composition of the underlying atmosphere significantly more challenging. The diverse nature of aerosols across the planetary population means that a single prescription of their effects is not possible. The large-scale effects of aerosols are intricately intertwined with their source regions, the general circulation, the incident stellar energy, and the specific radiative properties of the aerosol particles. The aerosol radiative properties themselves are heavily influenced by material composition and shape. A full understanding of aerosols in planetary atmospheres is a complex coupled problem. In this talk, I discuss the current thought on aerosols in the context of planetary atmospheres with a focus on progress made in modeling and observation. Particular interest is given to interpretations of exoplanet observations, current and future. All roads to exoplanet characterization lead through the haze, not despite of it.

6PA.2

Understanding the Photochemical Production of Complex Organosulfur Compounds in Archean-Analog Aerosols: Implications for Early Earth and Exoplanets. CADE CHRISTENSEN, Nathan Reed, Margaret Tolbert, Eleanor Browne, Jason Surratt, *University of North Carolina at Chapel Hill*

The Archean atmosphere on Earth was anoxic and mostly composed of nitrogen, with trace gases such as methane (CH4), carbon dioxide (CO2), and sulfur gases (e.g., hydrogen sulfide (H2S) and sulfur dioxide (SO2)). These trace gaseous precursors can undergo photochemical reactions that produce organic and inorganic sulfate aerosols. Understanding the molecular-level chemical composition of these photochemically-generated aerosols is central to the atmospheres of the Archean Earth and potentially Archean-like atmospheres elsewhere. Recent work has challenged the assumption that inorganic sulfur is the only reservoir for sulfur in these atmospheres by showing large portions of total aerosol formation being linked to organosulfur compounds. The structures and formation of these organosulfur compounds are currently lacking and could hold implications for the early beginnings of life. We will describe results obtained from laboratory analog experiments using an irradiated mixture of 0.5% CO2, 0.1% CH4 and 5 ppm H2S in a nitrogen background to investigate the formation of organosulfur aerosols. A hydrophilic interaction liquid chromatography (HILIC) method coupled to electrospray ionization and a high-resolution quadrupole time-of-flight mass spectrometer (ESI-HR-QTOFMS) was used for the offline molecular-level characterization of resultant organosulfur-containing aerosols. Tandem mass spectrometry (MS/MS) results obtained from HILIC/ESI-HR-QTOFMS analyses provided details about various functional groups and overall molecular structures for particulate sulfur species. A complex mixture containing a rich array of molecules was found, including C1-C4 species with sulfur found in multiple oxidation states. Ionizable sulfur functional groups such as sulfates, sulfonates, sulfites and sulfinic acids were detected. Compounds with more than one sulfur functional group provided tentative structures containing thiols, sulfite esters, thiocarboxylic acids, sulfides, sulfoxides, and sulfones. These results show that atmospheric chemistry produces complex organosulfur molecules that may be important as nutrients and for early metabolism as well as for our interpretation of sulfur in the geological record.

6PA.3

Aqueous Reactivity of Reduced Sulfur Species under Anoxic Conditions: Implications for Planetary Habitability. REBECCA RAPF, Sukrit Ranjan, Jackson Witkow, Raider Horn, Marco Botello, *Trinity University*

Sulfur plays a key role in planetary habitability, through the generation of photochemical aerosol haze layers which interact with radiation and influence climate. Sulfur is primarily supplied to the atmosphere in the S[IV] oxidation state as sulfur dioxide and then partitions into the hydrosphere as sulfite. The aqueous loss efficiency of sulfite is a main control on the global fate of S[IV]. If aqueous loss of S[IV] is efficient, then sulfur dioxide is rapidly scrubbed from the atmosphere with minimal influence on planetary climate or chemistry. If, however, aqueous loss of S[IV] is inefficient, then S[IV] accumulates in the hydrosphere-atmosphere system, resulting in the formation of significant photochemical haze formation. To date, the kinetics of abiotic sulfur reactions in aqueous models under anoxic conditions are not well constrained. Here, we report on laboratory studies that examine the thermal disproportionation and wavelength-dependent photolysis of reduced sulfur species, using Raman and UV-vis spectroscopy. These experimentally-determined rate constants are then incorporated into atmospheric and aqueous models, giving bounds on the likelihood of formation of optically thick sulfate or S_8 hazes, which can significantly impact planetary climate and UV irradiation and ultimately habitability.

6PA.4 – INVITED

Investigating the Formation and Properties of (Exo)Planetary Atmospheric Aerosols, a Cross-Disciplinary Research Endeavour. ELLA SCIAMMA-O'BRIEN, Erika Barth, Tanguy Bertrand, Jason Cook, Dale Cruikshank, Cristina Dalle Ore, Thomas Drant, David Dubois, Al Emran, William Grundy, Ashton Homyk, Sarah Hörst, Laura Iraci, Lora Jovanovic, Christopher Materese, Michel Nuevo, Zoé Perrin, Pascal Rannou, Claire Ricketts, Ted Roush, Farid Salama, Josh Sebree, Sandrine Vinatier, Diane Wooden, Xinting Yu, *NASA Ames Research Center, Moffett Field, CA*

Observations of cloud and haze particles in (exo)planetary atmospheres have led to the development of experimental studies as well as theoretical models to investigate their formation processes and to characterize their physical, chemical, morphological, and optical properties. Dedicated laboratory experiments allow the production of analogs of these solid materials under different experimental conditions (molecular precursors, temperature, pressure, energy source…) representative of different atmospheric environments, and their characterization with different diagnostic techniques. The laboratory-generated data (e.g. optical constants, spectral features, vapor pressure, grain morphology) can then be used as critical input parameters in models for the analysis and interpretation of observational data.

Here we present several examples that demonstrate how cross-disciplinary research projects, where experimentalists, modelers, and observers work together to answer science questions, allow expertise across different fields (Earth and Planetary sciences, material sciences) to be shared and misconceptions or missing key elements to be tackled by looking at the problem from different perspectives. The various studies to be presented combine (1) experiments producing analogs of (exo)planetary atmospheric aerosols (Titan, Pluto, exoplanets,…) using several laboratory facilities, (2) characterization of their chemical, physical, morphological, and optical properties, (3) modeling efforts and (4) the interpretation of observations. They show the importance of collaborative and comparative studies and how, by working in unison, the group can accomplish more than the sum of its parts by combining results into a higher-level understanding of the chemical processes taking place.

6PA.5

Preparatory Lab Experiments for the Upcoming Rocket Lab Mission as Part of the Morning Star Missions to Venus. KEVIN JANSEN, Sara Seager, Janusz Petkowski, Christopher Carr, Darrel Baumgardner, Margaret Tolbert, Weston Buchanan, Iaroslav Iakubivskyi, Steven Benner, Jingcheng Huang, *Massachusetts Institute of Technology*

Interest in Venus has recently been reignited following the controversial detection of phosphine in the Venus atmosphere, a potential indicator for life. Following this renewed interest, the Morning Star Missions, a series of astrobiology-focused missions to Venus, have been planned to probe Venus clouds. The mission aims to determine if the clouds are either capable of supporting microbial life, or contain signs of organic species despite Venus clouds containing high concentrations of sulfuric acid (>70% by mass). The upcoming Rocket Lab Mission to Venus, the first part of the Morning Star series of missions and the first primarily privately-funded small and low-cost mission to another planet, is set to launch in early 2025. This preliminary mission will send a single, newly developed instrument called the Autofluorescence Nephelometer (AFN) with the aim of characterizing the asphericity and refractive indices (RI) of cloud particles, as well as detecting potential organic compounds through fluorescence. The AFN directs a 440 nm laser onto cloud particles through a pressure vessel window and subsequently measures both polarized, backscattered light and fluoresced light from the particles. To understand and calibrate the expected data retrieved from the upcoming mission, a series of laboratory prototype AFNs have been developed and tested using materials with known RI and fluorescence properties, along with organic/concentrated sulfuric acid mixtures to mimic possible Venus cloud particles. Using the prototype AFN, we have successfully observed changes in fluorescence using particles with varying concentrations of fluorescein, a fluorescent dye, as well as aged formaldehyde/sulfuric acid mixtures. In addition, polarized scattering measurements have been able to detect changes in RI and particle asphericity, paving the way for RI retrievals. Overall these preliminary AFN laboratory experiments show great potential for cloud particle detection in the upcoming Rocket Lab Mission to Venus, as well for experiments on Earth.

6PA.6

Studying the Microphysics of Particles in Outer Solar System Atmospheres with PlanetCARMA. ERIKA BARTH, *Southwest Research Institute*

The Community Aerosol and Radiation Model for Atmospheres (CARMA) tracks the vertical transport, coagulation, and nucleation/growth/evaporation of particles in a column of atmosphere and solves for their radiative effects. PlanetCARMA applies the core CARMA physics to a number of planetary atmospheres, including Titan, Pluto, Jupiter, Saturn, Uranus, and Neptune. This allows for a comparison/contrasting of aerosol types and the important processes controlling aerosol properties in these planetary atmospheres. Titan's haze layer includes photochemically created carbon-hydrogen-nitrogen particles coated with various hydrocarbon and nitrile ices. At the poles, the larger vapor abundances and seasonal cooling allow for the formation of optically thick clouds of HCN (hydrogen cyanide), C6H6 (benzene), and C2H6 (ethane). Methane (CH4) is abundant enough to form clouds in the troposphere. Raindrops from these clouds may provide a mechanism of transporting the stratospheric ices to Titan's surface. Pluto's atmosphere includes some of the hydrocarbon and nitrile volatiles as Titan's, but at lower pressures and colder temperatures. Still, modeling has shown that nucleation of these species can occur onto the haze particles seen from the New Horizons flyby. However, the cold temperatures may inhibit further growth by condensation, particularly for HCN. In the giant planet stratospheres, impact delivered water vapor may homogeneously nucleate to form water ice particles that can then serve as condensation nuclei for hydrocarbons deeper in their atmospheres.

7AC.1

Impacts of Peroxy Radical Fates on α-Pinene Secondary Aerosol Composition. ERIK HELSTROM, Lesly Franco Deloya, Hannah Kenagy, Anita Avery, Manjula Canagaratna, Jesse Kroll, *MIT*

Biogenic volatile organic compounds such as α-pinene are major (and often-studied) precursors of secondary organic aerosol (SOA). A vital branching point in the chemistry of these species in the atmosphere is the fate of peroxy (RO_2) radicals, formed upon attack by an oxidant (e.g., OH). Though previous laboratory investigations have assessed the effects of RO_2 chemistry on SOA yields, the impact of RO_2 fate on molecular composition of the aerosol has not been explored in a systematic way. Here, we use explicit chemical modeling to inform a series of α-pinene oxidation experiments that span various atmospheric RO_2 chemical regimes, modifying the relative competition between the RO_2 + NO, RO_2 + HO_2, RO_2 + RO_2, and isomerization pathways. An Aerosol Mass Spectrometer (AMS) and Extractive Electrospray Ionization Time of Flight Mass Spectrometer (EESI-ToF-MS) are deployed to characterize SOA composition in each of these experiments. We demonstrate direct measurements of the dynamic evolution of SOA composition during its formation and comprehensive changes in aerosol composition between experiments. We evaluate these changes in the signal response of the EESI to the SOA as a function of RO_2 regime, identifying major species dependent on the importance of RO_2 reactions with both NO and HO_2, as well as on RO_2+RO_2 reactions. We comprehensively evaluate these changes by exploring shifts in the average elemental ratios, double bond equivalency, and the relative abundance of nitrate functionalization and dimerization. We then compare these speciated measurements with the bulk measurements made in the AMS. Further, we evaluate potential molecular tracers of RO_2 chemistry, possibly enabling the field characterization of the RO_2 chemical conditions during ambient SOA formation.

7AC.2

Modeling Secondary Organic Aerosol Formation via Nighttime Atmospheric Chemistry of Phenolic Compounds. QUANG TRAN VUONG, Myoseon Jang, Jiwon Choi, *University of Florida*

Increased wildfires and prescribed burnings (i.e., agricultural activities) elevate emissions of organic gases and these fire plumes degrade air quality via the formation of secondary pollutants such as ozone and secondary organic aerosol (SOA). Phenolic compounds in biomass burning smokes are known to be significant contributors to SOA production. Unlike traditional aromatic hydrocarbons, phenolic species can be oxidized during daytime and nighttime due to their high reactivity with atmospheric oxidants, such as hydroxyl radical, ozone, and nitrate radical. In this study, the SOA formation from nighttime chemistry of phenol and catechol is predicted using the UNIfied Partitioning Aerosol Reaction (UNIPAR) model, which can predict SOA mass and aerosol properties via multiphase reactions of precursor hydrocarbons. The daytime oxidation of phenol with hydroxyl radicals forms highly oxidized molecules such as multi-hydroxyphenols and multifunctional ring-opening products, which effectively yield SOA. However, phenols can form a persistent phenoxy radical (PPR), which can engage in the catalytic consumption of ozone, intervene the NO_X cycle, and retard the formation of ozone and SOA. In nighttime chemistry with nitrate radicals, phenol can also form PPR along with nitro-phenols and ring-opening products. Catechol can be produced from daytime phenol oxidation (hydroxyl radical reactions), and directly emitted from biomass burning. Phenol's reaction with ozone is negligible while catechol, which is more reactive, can react with ozone rapidly yielding ring-opening products. Through this study, product distributions of oxidized phenol or catechol are explicitly predicted for three oxidation paths (hydroxyl radical, ozone, and nitrate radical) in daytime and nighttime and applied to the UNIPAR model under varying environmental conditions (temperature, humidity, NO_X levels, and inorganic seed types) to demonstrate the model performance. The suitability of gas mechanisms and SOA model is validated by simulating data obtained in a large outdoor smog reactor (UF-APHOR) chamber during daytime and nighttime.

7AC.3

From the Smog Chamber to the 2D-VBS Parameterization of Secondary Organic Aerosol Formation.

DAMIANOS PAVLIDIS, Petro Uruci, Angeliki Matrali, Spyros N. Pandis, *University of Patras Greece*

A new measurement approach during smog chamber experiments is developed to facilitate the translation of the corresponding results to secondary organic aerosol (SOA) parameterizations that can be used in atmospheric chemical transport models (CMTs). The SOA concentration and composition is measured, at both ambient conditions and after heating with a thermodenuder at a range of temperatures, using a high-resolution proton-transfer-reaction time-of-flight mass spectrometer (PTR-ToF-MS) coupled to a CHARON inlet (Ionicon Analytik Inc.), a high-resolution time of flight aerosol mass spectrometer (HR-ToF-AMS) and an SMPS. At the same time the SOA is isothermally diluted in a second chamber to better constrain its volatility distribution. The gas-phase composition is also measured by the PTR-ToF-MS. The combined measurements are then used for the parameterization of the results both in the 2D- and the 1D-Volatility Basis Set frameworks (VBS).

The system was applied for the study of the SOA produced during the oxidation of large anthropogenic volatile (VOCs) and intermediate volatility organic compounds (IVOCs) by hydroxyl radicals, under high NOx conditions. The precursors used include aromatic compounds of increasing size (1,3,5-trimethylbenzene, 1,3,5-triethylbenzene and 1,3,5-tri-tert-butylbenzene) and cyclic alkanes (amylcyclohexane, hexylcyclohexane, nonylcyclohexane and decylcyclohexane). A significant quantity of SOA originated from all compounds investigated. While the large cyclohexanes exhibited higher yields compared to the aromatic compounds, the aromatic precursors generated more oxidized SOA. Most oxidation products of the cyclohexanes were semivolatile organics, while of the aromatics are IVOCs.

7AC.4

Modeling Peroxy Radical Conditions of Historical SOA Chamber Studies.

MATTHEW GOSS, Hannah Kenagy, Jesse Kroll, *MIT*

Laboratory measurements of secondary organic aerosol (SOA) formation underpin the representation of aerosols in global chemical transport models (CTMs). However, many of these measurements were performed before important recent developments in our understanding of peroxy radical (RO_2) chemistry. Previous chamber experiments were typically carried out under limiting conditions (where all RO_2 were assumed to react with either NO or HO_2), but more recent research has demonstrated that other pathways such as RO_2 isomerization or RO_2-RO_2 reactions can be important, both in chamber experiments and in the atmosphere. In light of advances in our understanding of RO_2 chemistry, actual RO_2 fate and reported RO_2 fate from these earlier chamber studies may not always align, possibly skewing the SOA parameterizations that continue to be used in CTMs. Here, we identify past SOA yield studies that have been used to constrain CTMs, and model their chamber conditions using the Master Chemical Mechanism. This enables explicit estimates of relevant and typically-unquantified parameters such as RO_2 bimolecular fate and RO_2 lifetime, which directly affect experimental outcomes such as the degree of peroxy radical isomerization or peroxyacyl nitrate formation. Model outputs are compared with reported experimental conditions, and interpreted in the context of measured aerosol yields and CTM aerosol parameterizations.

7AC.5

A Systematic Comparison between Laboratory Chamber Measurements and Mechanistic Predictions of Complex Oxidation Reactions.

JIA JIANG, Lesly Franco Deloya, Erik Helstrom, Havala Pye, Rebecca Schwantes, T. Nash Skipper, Jesse Kroll, *Massachusetts Institute of Technology*

Recent advancements in laboratory techniques now enable the measurement of multifunctional organic compounds, presenting new opportunities for the development and refinement of atmospheric chemical mechanisms. However, the absence of standardized, systematic approaches limits the application of such datasets for chemical mechanism development. This study aims to bridge this gap by developing a new approach combining laboratory data with an explicit mechanism generator for the comparison against mechanistic predictions. We focus on α-pinene, a major biogenic volatile organic compound known to be an important source of secondary organic aerosol (SOA), and whose oxidation products we have examined in the laboratory under a wide range of chemical conditions. We use these data to evaluate the α-pinene mechanism within the recently-developed Community Regional Atmospheric Chemistry Multiphase Mechanism (CRACMM). Mapping of species measured in the lab to those simulated in the mechanism is done via use of an explicit mechanism generator, the SAPRC Mechanism Generation System (MechGen). This enables the comparison of model outputs with the measured oxidation products in both gas and particle phases. Such comparisons may improve our ability to accurately simulate α-pinene chemistry within models, and more generally provide a new, robust approach for assessment (and ultimately improvement) of atmospheric chemical mechanisms.

7AC.6

Rapid Deposition Prevents the Formation of Late-Generation Products and Aerosols in Real-World Atmospheres.

Chenyang Bi, GABRIEL ISAACMAN-VANWERTZ, *Virginia Tech*

Reactive organic carbon (ROC) species are important fuel for atmospheric chemistry and the formation of secondary organic aerosol. However, deposition can remove these compounds from the atmosphere prior to reaction, with impacts on atmospheric reactivity and aerosol formation downstream. Using a variety of simplified parameterizations based on physicochemical properties of compounds (Henry’s law constant, vapor pressure, and reaction rate constants), we estimate timescales for oxidation and deposition of a wide range of atmospheric compounds and present a framework for predicting and visualizing the fate of a molecule. While some compounds have relatively determined fates, a substantial portion of compounds have competitive fates between oxidation and deposition. We implement deposition into chemically explicit and volatility binned 0-dimensional box models, and find that deposition significantly suppresses the reactivity and aerosol formation of the atmosphere by removing early-generation products. Furthermore, deposition prevents the formation of large fractions (up to 90%) of downstream, late-generation compounds. The results of this study imply that formation of aerosol from multi-generational oxidation may be less important in ambient atmosphere than often considered, and that efforts to correct for deposition to walls in chamber experiments may be substantially overestimating aerosol formation.

7CE.1 – INVITED

Emission Profiles of Fluorinated Aerosol Precursors from Rain Jackets Measured by I-HR-ToF-CIMS. CLARA EICHLER, Michael Davern, Jason Surratt, Glenn Morrison, Barbara Turpin, *UNC-Chapel Hill*

Hydroxyl radical oxidation of fluorotelomer alcohols (FTOHs) is a source of secondary organo-fluorine aerosol in the outdoor atmosphere via formation of perfluoroalkyl carboxylic acids (PFCAs). Per- and polyfluoroalkyl substances (PFAS), including FTOHs, are present in many consumer products because of their water- and stain-repellent properties. These products can emit PFAS indoors, where consumer products are frequently stored and used. Therefore, consumer products may contribute to atmospheric FTOH emissions via indoor-to-outdoor transport. However, FTOH sources and emission rates are not well understood. We measured emission rates of 4:2, 6:2, 8:2 and 10:2 FTOH from new, old/used and “PFAS-free” rain jackets under realistic indoor conditions (T = ~20°C, RH = 50%) using a flow tube and iodide high-resolution time-of-flight chemical ionization mass spectrometry (I-HR-ToF-CIMS). When tested immediately “out of package”, we observed high initial emission rates of up to 790 pg/h/cm^2 followed by a decay for 6:2, 8:2 and 10:2 FTOH. Peak emission rates correlated moderately well ($R^2 = 0.32$-0.83) with FTOH material-phase concentrations determined by gas chromatography-mass spectrometry (GC-MS). When the same materials were tested after airing out, resulting emission rates were more constant. This emission behavior is consistent with that of volatile organic compounds (VOCs), rather than semi-volatile organic compounds (SVOCs). The old/used rain jackets we measured exhibited, on average, higher emission rates and contained a broader range of neutral PFAS than the new jacket materials. FTOH emissions from high emitting household fabrics could plausibly explain FTOH concentrations measured in the 11-home Indoor PFAS Assessment (IPA) Campaign.

7CE.2

Automated Liquid Calibration Inlet for Online Measurements of Airborne PFAS. CHENYANG BI, Michael Davern, Clara Eichler, Mitchell Alton, Anita Avery, Nathan Kreisberg, Barbara Turpin, Jason Surratt, John Jayne, Manjula Canagaratna, *Aerodyne Research Inc.*

Per- and polyfluoroalkyl substances (PFAS), also known as “forever chemicals”, are widely used as water-resistant coatings and surfactants in many consumer products. They may not strongly bond to the polymer matrix and can leach out of the source products, making exposure to those potentially toxic chemicals an important concern. PFAS in air are traditionally collected and then analyzed offline. These “offline” sampling techniques are often time-consuming and can cause losses of more volatile species. Some early attempts have been made to apply online chemical ionization time-of-flight mass spectrometers (CI-TOF-MS) for PFAS measurements in the air. However, challenges remain with the in-situ, automatic calibration of the instruments for measuring PFAS. In this work, we demonstrated an automated inlet for online liquid calibration that is compatible with Vocus CI-TOF-MS. The inlet supports in situ, programmed calibrations using liquid chemical standards for online quantification of airborne PFAS such as fluorotelomer alcohols (FTOHs), fluorotelomer diol (FTdiOHs), perfluorooctane sulfonamide ethanols (FOSEs), and perfluorooctane sulfonamides (FOSAs) with detection limits ranging from 0.2 to 2.7 pptv. As a proof-of-concept demonstration of the setup, the calibrated online mass spectrometers were applied to repeat previously reported measurements of PFAS emission rates from a variety of known sources present in indoor and outdoor environments.

7CE.3

Indoor Residential Exposure to PFAS and Emissions to the Outdoor Environment: Results from the IPA Campaign. Naomi Chang, Clara Eichler, Daniel Amparo, Elaine Cohen Hubal, Jason Surratt, Glenn Morrison, BARBARA TURPIN, *UNC-Chapel Hill*

The indoor environment is a potentially important location for exposure to per- and polyfluoroalkyl substances (PFAS) because people spend roughly 90% of their time indoors, where they frequently consume food and water, and store/use materials, articles and consumer products that contain PFAS. Additionally, PFAS concentrations in indoor air are typically higher than outdoors, and thus, buildings can be a source of PFAS to outdoor air. As part of the UNC Indoor PFAS Assessment (IPA) Campaign, we measured 9 neutral and 26 ionic PFAS in the air (gas and $PM_{2.5}$), dust, water, surfaces, cloth, and clothing in 10 homes in North Carolina over 9 months using ultra-high performance liquid chromatography-electrospray ionization tandem mass spectrometry (AB SCIEX Triple QuadTM 6500; UHPLC/ESI-MS/MS) or gas chromatography/electron impact mass spectrometry (Agilent; GC/EI-MSD). Using these data, we estimated indoor residential PFAS exposures via inhalation, ingestion and dermal routes for adults and 2-year-olds. Dietary exposures were not assessed. Exposures were dominated by neutral PFAS, and inhalation accounted for the majority of estimated exposure for both adults and 2-year-olds. Ingestion of PFAS from dust, surfaces and mouthing of fabrics was also a substantial contributor to 2-year-old exposure. Ingestion of PFAS from water, dust and surfaces were the main pathways for exposure to ionic PFAS. Dietary intake is poorly constrained, but literature values suggest that accounting for diet would roughly double exposures. We further estimate the indoor-to-outdoor emission rate of these 35 PFAS from all US single family homes to be approximately 3,200 kg yr^{-1}, dominated by neutral PFAS.

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.

7CE.4

Contribution of Condensed-Phase Hydrolysis to Atmospheric Production of GenX. Emma D'Ambro, BENJAMIN MURPHY, Ivan Piletic, Havala Pye, *U.S. Environmental Protection Agency*

Per- and polyfluoroalkyl substances (PFAS) are a class of human-made compounds that can be emitted to the atmosphere, transported downwind, and deposited where they may contaminate surface water, ground water, and private well water, especially in the vicinity of large point sources. During transport, chemical transformations may occur which modify the solubility and reactivity of the emitted PFAS. One such transformation involves the hydrolysis of acyl fluoride compounds to form products with carboxylic acid functionality, which exhibit considerably higher water solubility and therefore faster deposition. The hydrolysis process itself is known to proceed rapidly in condensed water, which we extrapolate here to atmospheric water media (e.g., cloud drops and aqueous aerosols). The rate limiting step for this conversion is likely to be absorption of the sparingly soluble acyl fluoride precursor into the condensed phase. We apply the Community Multiscale Air Quality model (CMAQ) version 5.4 to a case study in Eastern North Carolina to model the PFAS emissions and transport at fine scale (1 km) from the Chemours Inc. Fayetteville-Works. The CMAQ-PFAS results inform our understanding of the extent to which condensed-phase hydrolysis can substantially convert hexafluoropropylene dimer acyl fluoride (HFPO-DAF) to hexafluoropropylene dimer acid (HFPO-DA), or GenX, in the atmosphere before it deposits. We evaluate the model's predictions with deposition measurements of GenX in North Carolina.

7CE.5

UV Photooxidation Results in Efficient and Accelerated Remediation of PFAS Water Contaminants in Aerosol Microdroplets. RILEY WEATHERHOLT, Kaitlyn Chung, Bailey Bowers, Ryan Sullivan, *Carnegie Mellon University*

Per- and Poly-fluorinated Alkyl Substances (PFAS) are a class of thousands of synthetic compounds characterized by carbon-fluorine bonds, which impart both hydrophobic and hydrophilic properties. PFAS are extremely persistent, ubiquitous, and many are known carcinogens, immunosuppressants, and endocrine disruptors. PFAS therefore pose a great challenge to sustainability and chemical remediation. Photo-oxidative remediation is a promising technology for the degradation of PFAS. The high surface activity of PFAS allows their concentration to be enhanced through aerosolization, placing them in a unique chemical environment that can accelerate degradation kinetics. The oxidation rate of 6:2 fluorotelomer carboxylic acid (FTCA) in the droplet phase and in bulk solution was measured to determine if a rate enhancement was observed in microdroplets. Aqueous 6:2 FTCA droplets and bulk solution were subjected to VUV/UVC light, which also produces gas-phase ozone and hydroxyl radical oxidants in situ. We compared substrate degradation, defluorination, and transformation products between droplets and bulk using both targeted HPLC-QQQ-MS and nontargeted UPLC-Orbitrap-MS. By using wavelengths that split water and molecular oxygen, we observed facile degradation of 6:2 FTCA in droplets and bulk solution without any added reagents. We observed fluoride production and a homologous series of perfluorocarboxylic acid (PFCA) transformation products, indicating perfluoryl chain-shortening of the 6:2 FTCA in addition to removal of the $–CH_2C(O)OH$ head group. Actinometry and radical probe experiments measured the steady-state hydroxyl radical concentration in droplets and bulk to determine when the kinetics are droplet-accelerated. More recent experiments compared the kinetics and products of 254 nm UVB to 193 nm VUV aerosol photodegradation. The Iodide CIMS method we recently developed enabled direct measurements of the degradation kinetics and gas and aerosol-phase products. These results represent an important step toward lower-cost PFAS remediation and mineralization, which can enable water treatment and reuse by removing ultrapersistent micropollutants.

7HR.1

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

Measurement of the distribution of airborne fiber length and number count in an air sample is important to assess exposures to asbestos and elongated mineral particles (EMPs) in workplace atmospheres. Exposure to noncommercial EMPs with the potential for asbestos-like health effects is an emerging issue. Phase contrast microscopy (PCM; NIOSH method 7400) is commonly used for assessing inhalation exposure to airborne asbestos or other EMPs; however, the method is labor- and time-intensive, especially for dilute samples. In addition, PCM lacks the capability to accurately count, size, and identify all fibers collected on filters with robust counting statistics. In this study, a flow imaging microscopy (FIM) method was investigated for measurement of number and fiber length distribution. First, monodisperse polystyrene latex count and size standards with microspheres in the diameter range of 2 µm -70 µm were used to examine counting and sizing accuracies of the FIM method, with objective lens magnifications of 4X and 10X for spherical particles. Then, test glass fibers were either i) prepared as a suspension in deionized water from bulk fiber powder or were ii) aerosolized by vortex shaking of glass fiber powder and collected on cascade mesh micro-screens with different pore sizes to obtain fiber samples with different lengths. Sizing accuracy of the FIM for spherical particles was verified in the range 5-70 µm with less than 13 % and 3 % difference for 4X and 10X, respectively. FIM measurement of fiber length distributions with 10X for geometric mean lengths in the range of 14.0 to 20.0 µm was in reasonable agreement with the PCM, resulting in about a 12.4.% difference. The study demonstrates that the high-throughput measurement capability of FIM shows promise for conducting fiber analysis of workplace air samples at significantly reduced time and/or cost and robust counting statistics.

7HR.2

How the Use of an Atmospheric Smog Chamber Allows Us to Investigate the Impact of Urban Air Pollution on the Exacerbation of Pulmonary Fibrosis. AMBRE DELATER, Zakaria Maakoul, Elie Al Marj, Aline Gratien, Lucy Gerard, Juan Camilo Macias Rodriguez, Mathieu Cazaunau, Edouard Pangui, Antonin Berger, Cécile Gaimoz, Bénédicte Picquet-Varrault, Dominique Marchant, Jean-François Bernaudin, Emilie Boncoeur, Clément Buissot, Audrey Der Vartanian, Sophie Lanone, Patrice Coll, Carole Planes, Nicolas Voituron, *Université Paris Cité and Univ Paris Est Creteil, CNRS, LISA*

Several epidemiological studies suggest that air pollution promotes the incidence and acute exacerbation (AE) of idiopathic pulmonary fibrosis, although the mechanisms involved are not fully understood. In this context, our aim is to evaluate the biological impact of urban atmospheric pollution (low- and middle-levels) on different cell types of the normal and fibrotic lung, and the subsequent effects on lung fibrosis progression. To this end, we exposed mice presenting or not progressive pulmonary fibrosis (induced by repeated bleomycin treatment) to realistic atmospheres generated at the laboratory, representative of atmospheric episodes observed in a city, for one week. The targeted atmospheres were the ones of the Paris metropolis (France) i) during summer and ii) during winter. These atmospheres were simulated at the laboratory, starting from Air Quality survey networks data and from literature data, using the PolluRisk platform. The platform consists of a smog chamber (CESAM - a national instrument in France dedicated to study the multiphase atmospheric processes) where primary pollutants (gas and particles) are injected and aged to form secondary products, before being injected into exposure devices where mice are placed. The simulation of the atmosphere of Paris in summer is characterized by low concentration of particles and gases in comparison with the atmosphere of Paris in winter, where biomass burning organic aerosols from wood heating (tubular furnace) were added, as well as higher NO2 concentrations to simulate the low atmospheric dispersity of species in winter. In the exposed mice, histopathological and biological approaches were conducted to document acute alveolar damage and quantify pulmonary fibrosis. We will also define a gene expression profile and a molecular signature, and thus understand the physiopathology, the signaling pathways, and deduce possible therapeutic targets.

7HR.3

Comparing the Biocompatibility of Diffusion Flame-Generated Soot to Human Lung Cells by Two Commonly Used In-Vitro Cultures: Monolayer and Air-Liquid Interface. Durgesh N. Das, Paul Hamilton, Shubham Sunil Sharma, DHRUV MITROO, Benjamin Kumfer, *Veterans Research and Education Foundation*

In-vitro models are the avenues by which researchers evaluate initial biological responses and discover cellular pathways of mammalian tissues upon exposure to environmental pollutants. Perhaps the most well-recognized airborne environmental pollutant, soot, accounts for many pathologies associated with aerosol exposure. At present, several in-vitro models are employed to address similar questions, ranging from cell types to culturing conditions, because not everyone has access to latest technology and methodology.

To this end, we compare initial biological responses and some hallmark features of human pulmonary cells to soot, grown using two in-vitro methods: traditional monolayer coverage and the organ tissue equivalent (OTE) cultured the air-liquid interface (ALI). These are both not novel techniques, however, to our knowledge, the two most employed by researchers with roots in aerosol science. We treat human small airway epithelial cells (HSAEC; a commercially available primary cell line), cultured to provide both models, with laboratory-generated diffusion flame soot. Of the biological responses, we compare LD_{50}, oxidative stress, and mitochondrial damage and dysfunction. To obtain insight into the cellular pathways occurring in both models, we monitor for makers of necrosis vs apoptosis. This is complemented with immunohistochemistry staining and immunofluorescent staining (e.g., for cleaved Caspase 3 during apoptosis). We hope this can allow a more direct comparison across studies that employ both models, current and prospective, and/or reveal any obvious discrepancies.

7HR.4

Applying Condensational Growth for Direct Exposure of Human Small Airway Epithelial Cells to Flame-Generated Soot.

SHUBHAM SUNIL SHARMA, Dhruv Mitroo, Durgesh N. Das, Paul Hamilton, Joseph V. Puthussery, Rajan K. Chakrabarty, Benjamin Kumfer, *Washington University in St. Louis*

Soot emitted from combustion sources such as wildfires and activities such as driving, cooking, and open waste incineration has been shown to cause adverse heath effects in various mammalian cells. Physicochemical properties such as particle size, morphology, surface area, surface reactivity, and PAHs content vary by source and influence toxicity in cells. Preserving these properties during in vitro studies is crucial for accurately assessing their impact on cell health. Traditional cell exposure by addition of suspension of particles in cell media is challenging due to colloidal instability and difficulty in preserving the original size distribution and morphology. To overcome this challenge, methods to directly deposit aerosols onto the cells such as electrostatic deposition and impaction through condensational growth have been used to by different research groups but, to the best of our knowledge, the application of condensational growth with deposition has not yet been explored with soot aerosol. Exposure through condensational growth better simulates the mechanism of real-life exposure by mimicking the warm and humid air pathway to lungs. However, the condensational growth of particles is sensitive to the number concentration and the temperature gradients in the growth tube. In the work here, a parametric study using a Spot Sampler™ (Handix Scientific Inc.) is performed to optimize the number concentration and growth tube temperatures and an exposure system is developed that directly exposes primary Human Small Airway Epithelial Cells (HSAEC) growing in a standard multi-well culture plate to the flame-generated soot aerosol with controlled dosage. The effect of operating parameters on cell exposure is presented for both premixed and non-premixed flame generated soot. The study also compares an initial biological response observed between direct exposure using condensational growth and exposure through processing of particles collected on a filter. The combined system provides an unique platform for assessing toxicity using exposure through condensational growth of soot, and for elucidating the particle properties most relevant to health outcomes.

7HR.5

Visualization of Water Uptake by Human Respiratory Aerosol Components with In Situ Transmission Electron Microscopy.

MARTIN AHN, Taylor J. Woehl, Akua Asa-Awuku, *University of Maryland, College Park*

Bioaerosols are complex mixtures of biological matter (viruses, proteins, lipids) and inorganic/organic matter (salts, surfactants) that are a common respiratory virus transmission route. Liquid bioaerosol droplets with sizes between 1 – 100 µm are readily generated by human respiratory/vocal activities, such as talking, coughing, and breathing. These liquid particles are produced within the lungs, where the relative humidity (RH) is ~100%, and rapidly dry once exposed to atmospheric RH (≤ 80% RH) to form either solid or semi-solid particles. The resulting particle morphology and drying rate during this phase transition have been suggested to impact the virus viability within these bioaerosols. However, the detailed dynamics of the drying process and how it impacts the final structure of solid bioaerosols remain unknown due to a lack of observations of this nanometer scale dynamic process. In situ transmission electron microscopy (TEM) allows for the visualization of relevant nano-scale processes (e.g., phase-separation, nucleation) under controlled environmental conditions that may not be clearly resolved by conventional optical or fluorescence microscopy. Here we developed RH-controlled in situ TEM to visualize wetting and drying of bioaerosol droplets and aerosols under various environmental conditions. We utilized a MEMS-based in situ TEM sample cell, where RH control was achieved by mixing humidified and dry air streams at various volumetric flow rate ratios. Human respiratory droplets were modelled by aerosolized mixtures of bovine serum albumin (BSA) and sodium chloride (NaCl) into micron sized droplets. The dry model particles were impinged on silicon nitride sample chips and assembled into the in situ TEM sample cell and observed under controlled RH using in situ scanning TEM (STEM).

7IM.1

The Condensation Particle Counter For Rapid Atmospheric Measurements (CPC FARM): Instrument Description and Field Results. DARREN CHENG, Stavros Amanatidis, Gregory S. Lewis, Coty Jen, *Carnegie Mellon University*

New particle formation (NPF) describes the process where gas molecules in the atmosphere nucleate to form a stable ~ 1 nm particle that then grow into detectable sizes. NPF influences global climate by producing 50% of the global cloud seed particles and thus altering cloud albedo and lifetimes. However, time resolution and sensitivity of current instrumentation are inadequate in measuring the reactions that produce sub-3 nm particles, the size range of freshly nucleated particles. Currently, instruments used to measure 1 – 3 nm particles include the scanning mobility particle sizer (SMPS) and the particle size magnifier (PSM). Both these instruments scan through a size distribution over minutes and therefore do not provide continuous measurements of a single particle size bin. This poor time resolution introduces uncertainty due to fluctuations in the sampled airmass and limits the identification of key processes that can result in the rapid growth of 1 – 3 nm particles. The SMPS also relies on charged particles which greatly decreases instrument sensitivity and introduces uncertainty due to extremely low and highly uncertain charging efficiencies for sub-10 nm particles. Here we present the CPC FARM as a high sensitivity and high time resolution method to measure the concentration of freshly nucleated particles. The CPC FARM consists of five water CPCs each tuned to operate at a different minimum detectable particle size. The particle size distribution is calculated using the differential measurements across the channel. The CPC FARM was deployed in Pittsburgh, PA in Fall 2023, and the measured size distribution was compared to a pair of SMPSs. Experimental results indicate that the CPC FARM can observe NPF events not captured by the SMPS which will greatly improve the calculation of NPF rates.

7IM.2

Optimizing Design Parameters for Miniaturized Condensation Particle Counters: Insights into Ultrafine Particle Detection. MOLLY J. HAUGEN, Shaamrit Balendra, Ashkay Kale, Lee Weller, Adam M Boies, *University of Cambridge*

Urban particulates originate from diverse source, with near-source particles typically measuring less than 0.1 µm (here noted as ultrafine particles). These ultrafine particles pose significant challenges due to their ability to penetrate deep into the lungs, thus raising concerns for human health and overall air quality. Effective monitoring of these aerosols, both indoors and outdoors, is crucial for informed policy-making and monitoring air quality improvements. However, typical air quality sensors that focus on PM ($PM_{2.5}$ and PM_{10}), are primarily optical particle counters (OPCs). These types of sensors face limitations in detecting ultrafine particles, given their lower detection threshold of approximately 0.3 µm.

This study delves into the fundamental principles governing the lower size limits of a water-based condensation particle counter (CPC), drawing inspiration from prior research on the phenomena within the condensation particle counter growth chamber (CPC-GC).

The work reveals essential relationships critical for optimizing CPC-GC design including supersaturation, heat transfer, penetration, and droplet growth. These relationships, depicted within a design space framework, must also consider residence time and tube radius, both of which are crucial for achieving optimal droplet sizes and operational parameters.

By leveraging these insights, future iterations of CPC-GC designs can be miniaturized to operate within the optimized range delineated in the design space. This advancement holds promise for next-generation high-performance miniaturized CPC-GC designs and the development of portable CPC sensor systems, poised to revolutionize air quality monitoring.

7IM.3

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

As concern over ultrafine particles and the creation of particle-number-based standards become a priority in the regulatory framework around air quality, issues around broadly accessible and scalable instrumentation have come to the fore-front. OpenCPC – a low-cost and open source condensation particle counter – has been developed to help bridge the gap between low-cost optical counters often used for community monitoring that typically can't measure ultrafine particles and high-performance but more costly lab grade CPCs.

The OpenCPC offers a low-cost optical design, featuring a lensless scattered light collection system and a tightly focused laser beam smaller than the nozzle diameter. Implications of counting only a fraction of the aerosol exiting the nozzle and particle-size-dependent counting efficiency is explored in this work. To overcome these challenges, a newly developed correction algorithm allows for both particle size and fractional counting to be corrected by a simple process. Measurements of concentration linearity to reference devices (a TSI 3025a and a faraday cup electrometer) are performed over the range of 10 to 150,000 particles/cm^3 to validate the performance of the correction methods.

One defining feature of a CPC is the particle-size-dependent counting efficiency for an incoming aerosol, often termed the cut-off curve. For laminar flow designs, such as the OpenCPC, this curve is proportional to the temperature difference between the saturator and condenser, and material composition of the aerosol. In this work we explore the performance of the OpenCPC over a range of saturator and condenser temperatures using monodisperse aerosol comprising different materials. These empirical results are used to help close a computational fluid dynamics model of the OpenCPC over the tested temperature ranges.

This work was supported by a gift from the Balvi Philanthropic Fund and by contributions from M. Pang, R. Andreasen, C. Libby, L. Goessling, and J. Stam.

7IM.4

An Online Condensation-based Technique to Measure the True Volume and Density of Aerosol Particles. CYPRIEN JOURDAIN, Julie Pongetti, Jonathan Symonds, Adam M Boies, *University of Cambridge*

The knowledge of the true volume of nanoparticles has significant implications in many fields, including spectroscopy, drug delivery, climate science, and energy harvesting. In fact, light absorption and scattering - as well as related mechanisms such as incandescence and photoacoustics - which form the base of well-established techniques in aerosol science, depend on the particle volume. However, there is no online technique to measure the true volume of nanoparticles, whose measurement instead relies on equivalent forms such as the mobility-derived volume assuming spherical particles or cumbersome *ex situ* analysis. Similarly, the material density of nanoparticles is commonly assumed based on bulk measurements owing to a lack of available techniques. This estimation is uncertain as aerosols are usually complex mixtures with oxidation and/or coating layers, which can drastically alter the density.

In this work, a technique is presented that allows direct measurement of the volume of nanoparticles based on the controlled condensation of heavy oils. The growth apparatus consists of a high-temperature stage used to saturate the aerosol flow with oil vapor and a low-temperature stage to force the oil molecules to diffuse towards the sample particles surface. The design, supported by computational fluid dynamics simulations, creates a high supersaturation region close to the condenser axis, promoting condensational growth while minimizing losses.

The results show that by carefully selecting the operating temperatures of the saturator and condenser, a region exists where all the sample particles are in the spherical droplet mode. From measurements of the relative changes in mass and mobility, the volume of the encapsulated nanoparticles is thus inferred. After validation with spherical PSL and sintered silver particles, for which the geometric volumes are successfully retrieved, the technique is applied to silver and soot agglomerates.

7IM.5

Boosting the Detection of Flame-formed Sub-5nm Materials by Operating the Saturator Inlet of a Water Condensation Particle Counter (WCPC) with Different Condensing Fluids. Farnaz Khosravi, Arantzazu Eiguren-Fernandez, Gregory S. Lewis, FRANCESCO CARBONE, *University of Connecticut*

Combustion emissions are major contributors to air pollution in urban areas and advancements in instrumentation for detecting ever smaller materials are crucial for their effective monitoring and more stringent regulation. Among aerosol metrology instruments, Condensation Particle Counters (CPCs) stand out due to their ease, robustness, and affordability of operation as well as their ability to detect charged and neutral particles with extremely low number concentrations. However, the detection efficiency of any CPC is influenced by various factors such as the size, charge, and shape of the detected materials as well as their composition and wettability by the condensing fluid(s). The effects of these parameters can be substantial and elusive to estimate for materials smaller than 5nm whose detection efficiency needs, therefore, to be quantified by ad-hoc calibrations. This study characterizes the detection efficiency of flame-formed sub-5nm materials by a Water-based CPC (WCPC) prototype equipped with a saturator inlet to boost their growth and detection via condensation of a secondary fluid alongside water. The efficiency of the device in detecting naturally charged flame carbonaceous materials by operating the saturator inlet with DiEthylene Glycol (DEG) has been recently characterized in the literature. This work reports the same characterizations when operating the saturator inlet with different working fluids and also quantifies the detection efficiency of uncharged materials. In addition to DEG, the tested fluids are three alcohols including n-butanol which is the most commonly used CPC fluid. Experiments are performed to identify the device temperatures and flow rate to maximize the detection of the smallest materials with each of the considered fluids and are complemented by COMSOL modeling of such optimal operating conditions. The operation of the saturator inlet with any of the tested alcohols boosts the detection of flame-formed materials, regardless of their charge state, with performances comparable to that of DEG.

7IM.6

Field Evaluation of a Community Condensation Particle Counter for Ultrafine Particle Monitoring. SUSANNE HERING, Arantzazu Eiguren-Fernandez, David Pariseau, Judith Chow, John Watson, Xiaoliang Wang, *Aerosol Dynamics Inc.*

With the increasingly widespread monitoring of air pollutants at the community level, there is a growing need for accurate and reliable data at a reasonable cost. Especially challenging are measurements of ultrafine or nanometer sized particles, as these are too small to be detected directly by optical sensors. Reported here is the field evaluation of a new, community condensation particle counter (cCPC) that targets this community measurement need. It utilizes quasi-adiabatic expansion coupled to single particle counting to monitor particle number concentrations in the 5-2500 nm size range. An air sample is captured in a Nafion-walled cell, humidified at the cell temperature due to water transport across the Nafion membrane, and then temporarily cooled by rapid evacuation of the chamber to approximately 80% of the initial pressure. The expansion of the humidified air sample creates a region of supersaturation within the central region of the cell, leading to the condensational growth of the particles. The droplets formed are counted individually as they exit the cell, while the sample volume is determined from the concurrent measurement of the chamber pressure. This yields a 'first principles' measurement of ultrafine particle concentrations. The only parameters entering the derivation of the particle concentration are the total particle count, the change in pressure, and the physical volume of the cell. Laboratory evaluation with size-selected aerosol show the counting efficiency is above 50% at 5nm, and above 95% for particles larger than 30nm.

Reported here are results from the field evaluation of these new cCPCs. Three cCPCs were deployed over a four-month period, from November 2023 to March 2024, at the Reno4 air quality monitoring station. This site, located near downtown Reno, NV, is part of the U.S. EPA NCore Monitoring Network. A research-grade condensation particle counter (CPC, Model 200, Aerosol Dynamics Inc.) was used as a reference. The coefficient of variation among the three collocated cCPCs was 3%. Comparisons with the reference CPC yielded coefficients of determination $R^2 > 0.99$, and the ratio of the mean cCPC to that of the reference CPC concentration ratios was 0.95–1.00. At the highest concentrations of ~40,000 particles/cm3, the cCPC data were 15% lower than the reference, an effect attributed to condensational heating. Additional field evaluations are planned for summer 2024, and results from these studies will also be presented.

This work was supported by NIH under Grant number R44-ES031458, and through in-kind support from Particles Plus Inc.

7NP.1

Aerosol Engineering of Battery Electrodes: A Review of a Decade of Spray Drying and Spray Pyrolysis of Intercalation and Conversion Materials. ADAM M BOIES, Manar Almazrouei, Maurits Houck, Jean de La Verpilliere, Michael De Volder, *University of Cambridge*

Modern lithium ion battery electrodes materials require precise morphology and crystalline structure to achieve high energy density, rate performance and cycle stability. Aerosol processes offer tools to impart desired morphological structure and material chemistry to high throughput production. This presentation details the last decade of work to synthesize battery electrode materials using both spray drying and high temperature spray pyrolysis that has moved from academic lab to industrial production. The ability to control particle morphology of desired chemistries with sizes ranging from 100 nm to 10 µm is an asset of spray processes. However, spray processes alone cannot provide sufficient residence times to achieve desired crystallinity, requiring costly post processing.

The presentation will detail the aerosol production of anode materials consisting of lithium conversion materials consisting of aluminium iron oxide and iron silicide particles stabilized with carbons. The reaction front of lithiation within the particles induces swelling and structural expansion of the powders upon electrochemical cycling. The morphology imparted by aerosol processing is critical to controlling the swell/shrink material properties, and thus the rate performance and overall cycle life of the materials. Hysteresis in charge-discharge processing leads to heat generation within the anode materials that can be dissipated by nano-scale carbon materials. The localized heat generation does not impede operation within individual cells, but at the pack level requires additional cooling systems that limits widescale adoption.

Alternatively, layered metal oxides that allow the intercalation of lithium ions within a robust crystalline lattice do not suffer from large hysteresis cycles, and thus overcome the limitations of heat generation. The production of mixed niobium oxide (e.g. Nb2O5) anode materials and layered cathode materials, such as lithium cobalt oxide (LCO) and nickel manganese oxide (NMC) can be achieved by aerosol processing. The resulting energy density, power density and cycle life of such engineered materials can rival or exceed materials produced by other processes. However, post processing the sprayed powders requires time consuming (hours) calcination steps in stationary high temperature (300-1000 °C) furnaces to achieve the desired layered crystalline structure properties. Thus, there are further opportunities for the development of advanced aerosol processes that achieve higher temperatures and prolonged residence times for greater efficiency of material production.

7NP.2

A General Flame Aerosol Route to Kinetically Stabilized Metal Organic Frameworks. Shuo Liu, Chaochao Dun, Jeffrey Urban, MARK SWIHART, *University at Buffalo - SUNY*

The ultra-high porosity and surface area, chemical diversity, and structural stability of metal organic frameworks (MOFs) have led to intense research activity and diverse applications in fields including catalysis, gas capture/separation, biomedicine, sensors, and atmospheric water harvesting. Over the past 30 years, numerous MOF synthesis methods have been developed, such as solvothermal synthesis, hydrothermal synthesis, and electrochemical synthesis. Aerosol synthesis by spray drying/spray pyrolysis has also been reported. However, synthesis of MOFs using a flame-driven aerosol process has not yet been reported. A key challenge is that the high temperature of conventional flame aerosol processes (~2000 °C) is incompatible with the organic linkers in MOFs. Here, we demonstrate production of MOF materials in a modified flame aerosol reactor in which droplet-to-particle conversion occurs in short (~50 ms) residence times and moderate temperatures (<500 °C) that do not degrade the organic component. In contrast to conventional wet-chemistry MOF synthesis methods that employ mild, near-equilibrium conditions and often form single-crystal MOFs with high crystallinity, the far-from-equilibrium flame aerosol process yields two distinct classes of MOFs, nano-crystalline MOFs and amorphous MOFs. We demonstrate the generality of this process by producing 9 different nanocrystal MOFs and 9 different amorphous MOFs, spanning most of the key MOF subfamilies and MOF-like structures (*e.g.*, Prussian blue analogues). More importantly, this far-from-equilibrium synthesis can integrate different metal cations within a single MOF phase, even when doing so is thermodynamically unfavorable. This can, for example, produce single-atom catalysts and bimetallic MOFs of arbitrary metal pairs. We demonstrate the flexibility of this approach by doping 4 different single-atom metal sites into different host MOFs. Furthermore, we show that reducing the noble metal component of a bimetallic MOF drives an exsolution process to form highly dispersed metal nanoclusters supported on the MOF. As a prototypical example of the power of this approach, we use exsolved Pt clusters on UiO-66-NH_2 as a CO oxidation catalyst that achieves 100% CO conversion at 130 ºC. This general synthesis route opens new opportunities in MOF design and applications across diverse fields and is inherently scalable for continuous production at industrial scales.

7NP.3

The Flat Premixed Droplet Seeded Flame (FPDSF): a versatile method to manufacture nanostructured catalyst materials.

OWEN S. FUHR, Farnaz Khosravi, Mahmoud K. Ashour, Francesco Carbone, *University of Connecticut*

The transition from a fossil-fuel-based economy to one that is sustainable and resilient necessitates the development of technologies accelerating the widespread adoption of renewable energy generation and storage. A key step toward this objective is developing cost-effective methods to manufacture highly active catalyst materials. This study demonstrates the versatility of the Flat Premixed Droplet-Seeded Flame (FPDSF) method in manufacturing metal-based nanostructured catalyst materials for sustainable energy applications from inexpensive precursors. Indeed, the FPDSF allows precise control of the synthesis-environment temperature, stoichiometry, and residence time and yields the desired product material from any liquid soluble precursors being stable in the desired mixing molar proportions. Herein an aqueous solution is made into monodisperse micron-scale droplets by a Vibrating Orifice Aerosol Generator (VOAG) and is mixed with a properly selected nitrogen-diluted blend of gaseous fuels and oxygen. A coupling tube directs the resulting aerosol upward through a narrow-channel honeycomb core at the exit of which the flow is laminar and nearly uniform and shielded from surrounding air by a coaxial nitrogen shroud flow. The FPDSF is stabilized just above the honeycomb outlet where the rapid heating of the droplets causes the pyrolysis of the precursors and yields the desired products. The so synthesized nanoparticles can be directly deposited via thermophoresis on a downstream water-cooled plate or characterized via dilution sampling followed by Differential Mobility Analysis to measure their Size Distribution Function (SDF). The FPDSF is used first to manufacture nearly monodisperse (2-5nm) Nickel oxide (NiO) nanoparticles upon assessing the impact of the solution concentration and droplet size on their SDF. Then, NiO is nanostructured with carbon in a fuel-rich FPDSF and the thermo-catalytic activity of the products is assessed via gas speciation. Additional experiments are being performed to manufacture nanostructured catalysts of nickel-molybdenum-cobalt (NiMoCo) as well as lithium-nickel-manganese-cobalt (NMC) for applications in batteries.

7NP.4

Embedding Pd into Flame-Aerosol Made and Leached Nanostructured Tin Oxide Particles Drastically Enhances Gas Sensing.

Katarzyna Jabłczyńska, Christian Kubsch, Alexander Gogos, SOTIRIS E. PRATSINIS, *ETH Zurich, Switzerland*

Combustion aerosols can uniquely embed noble metals into semiconducting particles (Güntner et al., 2022). Monocrystalline SnO_2 particles embedded with Pd and/or PdOx were made by flame spray pyrolysis (FSP) of appropriate precursors through microexplosions by droplet-to-particle conversion as the crystal size was proportional to the cube root of precursor solution concentration, C. These particles were air-annealed and leached with nitric acid for removal of metallic Pd from their surface. The SnO_2 crystal size varied from 11 to 24 nm and was in close agreement with the primary particle size determined by nitrogen adsorption. The embedded fraction of Pd ranged from about 30 to 80% of the nominal Pd content. This was achieved by judiciously varying the C, Pd content and the ratio of precursor solution to dispersion oxygen flowrates during FSP. The response of sensors made by doctor blading films of such particles to 1 ppm of acetone and CO was evaluated at 350 °C and 50% relative humidity. Embedding Pd/PdOx into SnO_2 significantly increased the sensor response: 2–6 times over that of pure or conventionally-made Pd-containing SnO_2 sensors at low nominal Pd-contents (0.2 mol%). For higher (i.e. 1 mol% Pd), the sensor response was enhanced by up to two orders of magnitude. This is attributed to Pd atoms in the SnO_2 lattice near the particle surface and/or Pd/PdOx clusters acting as nanoelectrodes into SnO_2 films (Tricoli & Pratsinis, 2010) and altering their transducing properties as shown by high resolution electron microscopy, XPS and baseline resistance measurements of pure and Pd-embedded SnO_2 sensing films (Jabłczyńska et al., 2024).

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7NP.5

Crumpled Graphene Oxide (CGO)-based Drug Delivery System.

YIMING XI, Shalinee Kavadiya, Daniel Bilbao, Roberts Evan, Russo Marco, Pratim Biswas, *University of Miami*

Various methodologies continue to be developed for the treatment of cancer, with emphasis on improved specificity and targeted delivery to tumor cells. A crumpled graphene oxide (CGO)-based drug delivery system (DDS) for cancer treatment was synthesized via an aerosol approach to achieve enhanced drug loading capacity with an anti-cancer drug doxorubicin (DOX). The proposed system with reduced particle size and preserved surface modifiability for active tumor targeting was compared to current graphene oxide (GO)-based systems. The particle size, the drug loading capacity, the drug release profile, and the toxicity of the synthesized DDS nanoparticles were evaluated in the study.

The synthesis method for the CGO was a one-step aerosolized approach using a Furnace Aerosol Reactor (FuAR). The sheet, two-dimensional (2D) graphene oxide (GO) was aerosolized into droplets and passed through a heated tube furnace to evaporate the solvents. During the solvent evaporation, the sheet 2D GO was crumpled into three-dimensional (3D) structures, CGO, due to the capillary force compression [1]. The synthesized CGO had a surface area of 79.091 m^2/g, that was 8.6 times larger than the sheet graphene oxide 9.178 m^2/g, because the crumpling had minimized pi-pi interaction-induced stacking of GO. The crumpled graphene oxide pre-treated with PEG surface modification (CGO-PEG) exhibited higher DOX loading capacity (0.3558 mg/mg) than GO (0.2667 mg/mg) and an asymptotic maximum percent release of 8.1%. In-vivo studies on mice indicated that the CGO demonstrated less toxicity (60 mg/kg) on mice than GO (7.5 mg/kg).

From preliminary results, the enhanced drug loading capacity of the crumpled structure with pre-treatment of PEG is attributed to both enhanced aqueous dispersion of particle and enlarged surface area after the crumpling. The presentation will further demonstrate additional data which will further provide improved understanding.

7NP.6

Using Electric Fields for 3D Nanoprinting of Aerosols into Nanoarchitectures.

Bingyan Liu, Shirong Liu, Jingui Ai, Yuxiang Yin, Yueqi Zhang, JICHENG FENG, *ShanghaiTech University*

Integrated circuits (ICs) fabrication requires cutting-edge nanoengineering techniques. The prevailing approach to enhancing computational power has been to miniaturize components in ICs. However, challenges arise due to the technological constraints of downsizing, interconnections, and materializing these components. Nanoscale 3D printing emerges as a promising solution to these challenges. At Aerosol Intelligence Laboratory (AIL), we have developed a method to print aerosols into expansive arrays of intricate 3D nanoarchitectures using “lines of forces”[1,2]. This technique is coined as “Faraday 3D Printing”[3], inspired by Faraday’s original field of lines, which are here repurposed as 3D nano-drawing tools. Distinct from wavelength-limited techniques, these drawing tools possess no downsizing limit[1,2], heralding a horizon for atomic-level manufacturing. Our proprietary system uncovers the vast potential of multi-material printing[2], a prospect that has remained largely untapped. By adeptly manipulating electric and flow fields, we attain remarkable flexibility in material selection and large-area printing, all while ensuring a high precision. This technology offers the capability to tailor optical, electronic, and mechanical attributes by modifying the material, geometry, feature size, and array periodicity of the printed nanoarchitectures. We contend that the transition from lithography to 3D printing within the spheres of nanoelectronics and nanophotonics signals a monumental paradigm shift, setting the research agenda of AIL for the future (more details about our work can be found at www.jcfenglab.com).

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7SC.1

Aethalometer AE36 Measurements: A Comprehensive Guide for Accurate Instrument Installation and Effective Data Analysis Techniques. MARTIN RIGLER, Matic Ivančič, Bálint Alföldy, Irena Ježek Brecelj, Asta Gregorič, *Aerosol Magee Scientific*

The Aethalometer AE36 is a widely used filter photometer capable of measuring the light-absorbing properties of aerosol particles, especially BC. In this Instrument Application Showcase, we present the performance of the new Aethalometer model AE36 (Aerosol Magee Scientific), developed to meet the needs of the monitoring community. The performance of the new Aethalometer has been significantly enhanced by redesigning the filter compartment, which is now robust to changes in relative humidity (RH). The AE36 is designed for long-term unattended operation, facilitated by a new self-cleaning procedure and a 20m filter tape.

In this comprehensive hands-on presentation of our instrument, we will demonstrate the thorough process of preparing the AE36 Aethalometer to measure the accurate and real-time black carbon concentrations and other light-absorbing properties of particulate matter. Our presentation will provide attendees with practical guidelines. These will cover the installation of the instrument itself, which is a critical component of the setup. Additionally, we will guide you through the installation of the sampling tube and the size-selective inlet. Our presentation will also explore the technical and scientific aspects of setting up various measurement parameters. This includes the C factor, also known as the multiple scattering parameter, the flow standard used for flow determination, and the limit settings for the relative humidity warnings in the sample stream and instrument’s filter compartment. Another important topic is the determination of Angstrom Absorption Exponents (AAE). These are essential for the optimal operation of the Aethalometer model, which is used for source apportionment.

We will also focus on instrument maintenance in our presentation. We will provide practical guidelines for cleaning the instrument and conducting Quality Assurance/Quality Control (QA/QC) tests. Regular maintenance is crucial for the longevity and accuracy of the instrument. Finally, we will introduce various methods of data analysis. This is the final step in our process, where we interpret the data collected by our instrument. We will guide you through different techniques and approaches to analyzing the data, helping you draw meaningful conclusions from your measurements.

7SC.2

Using a Vaporization Inlet for Aerosols Coupled with a Vocus Mass Spectrometer to Better Characterize Gas- and Particle-Phase Atmospheric Chemistry. Mitchell Alton, Philip Croteau, Andrew Lambe, Chase Glenn, Anita Avery, Leah Williams, MANJULA CANAGARATNA, *Aerodyne Research, Inc.*

Understanding the chemical composition of both atmospheric particles and the surrounding gas-phase is crucial for constraining how different compounds contribute to total atmospheric aerosol growth and chemistry. However, single-instrument measurements, mainly with the Filter Inlet for Gases and Aerosols (FIGAERO), are generally limited by time resolution of approximately an hour to heat and cool the collected sample. In this demonstration, we will show how to switch between particle- and gas-phase measurements using a Vaporization Inlet for Aerosols (VIA) at a user defined interval, not limited to filter collection times. The VIA will be coupled to a Vocus chemical ionization mass spectrometer and sample a stable aerosol source, switching between the gas- and particle-phases in real time. We will demonstrate how to take representative zeros, handle valve switching with minimal disruption to the measurements, and how changes in the operating conditions of the VIA change the observed signals. We will also discuss the optimal flow rates and residence times in the VIA for minimal thermal decomposition but maximum signals in the mass spectrometer.

7UA.1

In-Situ Secondary Organic Aerosol Formation Rate in Houston during the Tracking Aerosol Convection Interactions Experiment (Tracer) Field Campaign.

CHUN-YING CHAO, Fangzhou Guo, Donna Sueper, Subin Yoon, Kimberly Sauceda, Zihan Zhu, Sergio Alvarez, Shan Zhou, Manisha Mehra, Sujan Shrestha, Prakash Sharma, James Flynn, Rebecca J. Sheesley, Sascha Usenko, Don Collins, Robert Griffin, *Rice University*

Secondary organic aerosol (SOA) is a significant fraction of aerosol globally and has both anthropogenic and biogenic sources. Houston, Texas, the fourth most populous city in the U.S., is subject to a variety of industrial emissions, and previous studies emphasized different mechanisms of SOA formation between urban/industrial and suburban areas. To better understand the dynamics of SOA formation across Houston, this study (1) investigates the spatiotemporal chemical characteristics of aerosol and (2) utilizes a zero-dimensional model to estimate the SOA formation rate.

To understand the in-situ SOA formation rate in Houston, we deployed an Aerodyne high-resolution time-of-flight aerosol mass spectrometer from July to September 2022 during the TRacking Aerosol Convection interactions ExpeRiment (TRACER) field campaign. In July and August, the aerosol composition was measured for five to nine days at five locations across Houston, representing a range of suburban, urban, and industrialized locations. In September, measurements were conducted at a single industrialized site next to the Houston Ship Channel.

On average, OA contributed the most significant fraction of aerosol composition, 2.62 ± 2.49 µg/m3 (35.2%) from July to August and 7.55 ± 4.91 µg/m3 (57.8 %) in September. The diurnal pattern of OA exhibited peaks at rush hour (6 AM local time) and after times of strong solar radiation in the afternoon (~3 PM). We found three OA factors in this study using a positive matrix factorization (PMF) model: hydrocarbon-like OA (HOA), less-oxygenated OA (LO-OOA), and more-oxygenated OA (MO-OOA). Assuming the latter two represent SOA, a zero-dimensional model was used to estimate the SOA formation rate during TRACER. For MO-OOA, the largest formation rate aligned with intense photo-oxidation processes in the afternoon. For LO-OOA, however, the most significant formation rates occurred at night. The results indicate different mechanisms of daytime and nighttime SOA formation in Houston.

7UA.2

Assessing Spatiotemporal Variability of PM2.5 Sources in Salt Lake County Utah during Persistent Cold Air Pool Events.

Michael Hannigan, Colleen Reid, Daniel Mendoza, Emma Rieves, MiKyla Harjamaki, JONATHAN SILBERSTEIN, *University of Colorado at Boulder*

Persistent cold air pools (PCAP), also referred to colloquially as inversions, are responsible for some of the greatest enhancements in air pollution in Utah's Wasatch Front. PCAPs trap warm air beneath a layer of colder air, which results in the accumulation of particulates during the inversion. In Salt Lake County, PCAPs form with the greatest regularity during the wintertime. These meteorological events can continue for a period of up to several weeks, and pollutants may continue to accumulate until large scale meteorological events disperse pollutants accumulated during the inversion.

Previous research has demonstrated that source profiles of fine particulate matter can differ dramatically on local scales. During inversion episodes, limited mixing and transport may produce a differing suite of local and regional sources when compared to non-inversion periods.

Outdoor fine particulate matter (PM2.5) sampling occurred in seven homes across Salt Lake County (SLCo) during inversion season (November-March). Particulate matter source profiles across the seven sampling sites were generated using positive matrix factorization (PMF). PMF generated source profiles were compared during wintertime inversion and non-inversion periods to assess the influence of these climatic events on spatial distribution of fine particulate sources. A combination of statistical, spatial, and machine learning methods were employed to further understand the sources of fine particulates within SLCo and how regional climatic events may alter the dispersion and mixing of particulate sources.

7UA.3

Online Molecular Characterization of Oxygenated Organic Compounds in Gas and Particle Phases in Winter Fresno: Influences From Residential Wood Burning and Aqueous Phase Processing.

WENQING JIANG, Christopher Niedek, Anita Avery, Harald Stark, Manjula Canagaratna, Qi Zhang, *University of California, Davis*

Fresno, located in California's Central Valley, consistently experiences high levels of particulate matter pollution and poor air quality due to its complex emission sources and unique geographical and meteorological conditions. To investigate this, we performed an online gas and particle phase molecular characterization using an iodide-adduct chemical ionization mass spectrometer (CIMS) coupled with a Filter Inlet for Gases and AEROsols (FIGAERO) during the winter of 2023/2024 at the California Air Resource Board's Garland air monitoring site in Fresno. A wide variety of oxygenated organic compounds (OOC), representing both primary and secondary emissions sources, were detected. Notably, levoglucosan was one of the most prevalent OOC, with an average particle-phase concentration of 8.0 µg/m3 during the campaign. Levoglucosan and a group of phenols (e.g., guaiacol, syringol and vanillin) showed strong diurnal patterns, peaking between 9 pm and 1 am, which indicates that residential wood burning is an important source of PM in Fresno during the winter. Nitroaromatics (e.g., nitrocatechol, nitroguaiacol and nitrosyringol) reached their highest concentrations at night, with a secondary peak around 9 am. This pattern suggests that these nitroaromatics are primarily associated with nighttime biomass burning, with a minor contribution from vehicular traffic. Additionally, there are indications that the nighttime oxidation of phenols by nitrate radicals may also contribute to the secondary formation of nitroaromatics. Furthermore, the Fresno area experienced frequent fog events during the campaign, during which the concentrations of organic acids (e.g., oxalic acid and malonic acid) increased significantly. This rise in organic acids levels during foggy conditions suggests that aqueous-phase processing within fog droplets or hydrate aerosols plays a crucial role in the formation of SOA during the winter months in Fresno.

7UA.4

Air Pollution We Breathe: Assessing the Air Quality and Human Health Impact in a Megacity of Southeast Asia.

HAIDER KHWAJA, Fatim Sannoh, Zafar Fatmi, David Carpenter, Muhayatun Santoso, Azhar Siddique, Kamran Khan, Jahan Zeb, Mirza M. Hussain, *Wadsworth Center, University at Albany*

With 24 million inhabitants and 6.6 million vehicles on the roads, Karachi, Pakistan is one of the most polluted cities in the world. This is the detailed investigation on fine particulate ($PM_{2.5}$) mass, seasonal and temporal variability, chemical characterization, source apportionment, and health risk assessment at two urban sites (Malir and Kemari) in Karachi, Pakistan. Samples were analyzed for various inorganic components (anions, cations, and trace metals) and black carbon (BC). Several $PM_{2.5}$ pollution episodes were frequently observed, with annual mean concentrations of 140 ± 179 µg/m³ and 95 ± 40.9 µg/m³ at Kemari and Malir, respectively, 28 and 19 fold higher than the World Health Organization annual guideline (5 µg/m³). Kemari and Malir site had an air quality index (AQI) of 27% and 50% "Unhealthy for sensitive groups" for the winter and fall months, respectively. Annual average BC concentrations were 4.86 ± 5.29 µg/m³ and 4.52 ± 3.68 µg/m³, respectively. Chemical composition at both sites exhibited seasonal variability, with higher concentrations in winter and fall and lower concentrations in summer. A Positive Matrix Factorization (PMF) analysis identified 5 factors, crustal, sea salt, vehicular exhaust, fossil-fuel combustion, and industrial emission. The estimated number of deaths were higher in the colder seasons (fall and winter) at the Kemari (328,794 and 287,814) and Malir (228,406 and 165,737) site, respectively. The non-carcinogenic risk of $PM_{2.5}$ bound Pb, Fe, Zn, Mn, Cr, Cu and Ni via inhalation exposure were within the acceptable level (< 1) for adults. There was a potential non-carcinogenic and carcinogenic health risk posed by Pb and Cr through inhalation to children. Immediate attention should be paid by the policy makers for emission control strategies due to their significantly high contribution to $PM_{2.5}$ mass and health risks.

7UA.5

Estimation of Total and Biomass-Based BC at African Cities by Applying Image-Reflectance Method on Bam Tapes. Abhishek Anand, Richard Djarbeng, Evelyne Toure, Julien Bahino, Sylvain Gnamien, Allison Felix Hughes, Raphael E Arku, Victoria Owusu Tawiah, Araya Asfaw, Tesfaye Mamo, Sina Hasheminassab, Solomon Bililign, Daniel Westervelt, ALBERT A. PRESTO, *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 visible light from particle deposits on filters to measure black carbon (BC). US embassies 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 to extract red, green, and blue color channels for the filter samples. The red channel on the photo is used to estimate total BC concentration for that hour. We present 2 months of hourly BC concentrations for Pittsburgh (USA) and three cities in Africa, including Abidjan (Côte d'Ivoire), Addis Ababa (Ethiopia), and Accra (Ghana). Our BC estimates from BAM tapes showed strong correlation (R^2 ~0.96, slope = 0.97) with microAeth measurements at Addis Ababa, Ethiopia. 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 total BC for the measurement period at the Abidjan, Accra, Addis Ababa Central summer, Addis Ababa Central winter, Addis Ababa Jacros winter and Pittsburgh sites were 3.85 µg/m3, 5.33 µg/m3, 5.63 µg/m3, 3.89 µg/m3, 9.14 µg/m3 and 0.52 µg/m3, respectively. The average BC to $PM_{2.5}$ fraction varied between ~13 – 20% at African locations compared to only 5% in Pittsburgh. We further calculated biomass-attributed BC at these cities by quantifying the difference of BC individually estimated from red and blue channels. BC composition data, thus acquired, can be crucial in identifying emission sources and help in effective policymaking.

7UA.6

Seasonal Variations and Chemical Drivers of the Oxidative Potential of PM2.5 in Sao Paulo, Brazil: Insights from DTT and ESR Assays. CAROLINE FERNANDA HEI WIKUATS, Thiago Nogueira, Alessandra Tammaro, Flemming Cassee, Maria de Fatima Andrade, *University of São Paulo*

The oxidative potential (OP) of fine particulate matter (PM2.5) is a critical indicator of its ability to induce oxidative stress and impact human health. Despite extensive characterization of PM2.5 physicochemical properties and emission sources in São Paulo, Brazil, its toxicity remains insufficiently explored. Moreover, seasonal variations in the city, characterized by distinct wet and dry seasons, can influence PM composition and toxicological properties. This study aims to elucidate the relationship between PM composition, meteorology, and OP in São Paulo using dithiothreitol (OP^{DTT}) and electron spin resonance (OP^{ESR}) methods. The OP^{DTT} assay mimics in vivo superoxide radical generation, while OP^{ESR} assesses PM's capacity to generate free radicals, particularly hydroxyl radicals. We collected 24-hour PM2.5 samples in 2021 and 2022 (n = 284) near major roads, predominantly influenced by vehicular emissions, using a Partisol 2025i Sequential Air Sampler. Composition analysis was conducted via energy-dispersive X-ray fluorescence (EDXRF) and the Lab Organic Carbon-Elemental Carbon (OC-EC) Aerosol Analyzer. Our findings demonstrate significant seasonal variations (p-value ≤ 0.05), with winter samples showing 55.6% and 41.6% higher PM2.5 concentrations and OP^{DTT} values, respectively, compared to summer. Northeast, east, and southeast winds consistently correlated with higher values for PM2.5, OP^{DTT}, and OP^{ESR} across all seasons. Contributions from north and northwest winds during winter suggest influences from local and regional sources (e.g., biomass burning) on OP results. Since each method detects distinct PM chemical constituents (in general, DTT targets organic compounds while ESR focuses on transition metals), further analysis aims to elucidate the relationship between organics, OP^{DTT}, metals, and OP^{ESR}. This ongoing study contributes to advancing our understanding of PM toxicity in São Paulo, emphasizing the importance of targeted mitigation strategies to protect public health in urban environments.

8AC.1

Aqueous-Phase Chloramine Production as a Missing Chain in Atmospheric Chlorine Chemistry. YIJING CHEN, Men Xia, Jinghui Zhang, Epameinondas Tsiligiannis, Chao Yan, Runlong Cai, Guangjie Zheng, Junchen Guo, Zhaojin An, Yiran Li, Yuyang Li, Cheng Wu, Qipeng Qu, Xinyan Zhao, Chenjie Hua, Zongcheng Wang, Shuxiao Wang, Yongchun Liu, Lina Cao, Douglas Worsnop, Kebin He, Mattias Hallquist, Tao Wang, Jingkun Jiang, *Tsinghua University*

Chlorine radical (Cl·) profoundly impacts atmospheric oxidation capacity, and therefore climate change and air pollution. Chloramines, especially trichloramine (NCl_3), is a potential Cl· source. However, their formation mechanism remains elusive. We present evidence of aerosol aqueous-phase production of chloramines with atmospheric observations in Beijing and New Delhi, and develop a comprehensive box model which incorporates 38 aerosol aqueous reactions initiated by Cl_2 and NH_3 and phase transfer processes. The model well reproduces the diurnal variation of NCl_3 by sequential chlorination of NH_3, which produces photolabile chlorine while consumes Cl_2 and HOCl. Lacking chloramine chemistry in air quality models could significantly overestimate the role of Cl_2 and HOCl. Chloramines, especially NCl_3, are important Cl· contributors and intermediates in chlorine chemistry while, as a net result, this chloramine chemistry barely changes total chlorine radical production (P(Cl·)). Atmospheric production of chloramines could be ubiquitous globally with the co-existence of acidic aerosols, Cl_2, and NH_3, as evidenced by observations and our modeling analysis of chloramines in various environments. The contribution of chloramines to P(Cl·) is much higher in clean periods (up to 85%) than polluted periods (~5%) in Beijing, and in clean environments (e.g., ~64% in Toronto) than polluted areas (e.g., ~3% in New Delhi), implying a higher significance of chloramines in a cleaner future along with ongoing global efforts to mitigate air pollution. Overall, chloramine chemistry alters atmospheric Cl· production mechanism and represents a large missing contributor of Cl· in previous observations worldwide.

8AC.2

Enhanced Sulfate Formation through Synergistic Effects of Chlorine Chemistry and Photosensitization in Atmospheric Particles. RUIFENG ZHANG, Chak K. Chan, *King Abdullah University of Science and Technology*

Numerous studies have demonstrated that organic photosensitizers from biomass burning can generate oxidants to effectively convert inorganic and organic precursors into secondary aerosols. Particulate chloride ions can be internally mixed with organic photosensitizers in biomass burning particles. In this study, we investigate the impact of the interaction of chlorine chemistry and photosensitization on the oxidative potential of aerosols by utilizing SO_2 oxidation to form sulfate as an indicator. Mixed particles of chloride with glyoxal and its reaction products of ammonia of imidazole-2-carboxaldehyde (IC) were studied. Premixed NH_4Cl + glyoxal particles have a 4–5 times higher sulfate formation rate than premixed NaCl + glyoxal, particularly at low relative humidity, suggesting the role of photosensitization. Furthermore, the addition of IC resulted in an ~73-fold increase in sulfate production rate compared to NH_4Cl alone. No noticeable sulfate formation was observed in the presence of IC alone, likely due to the high particle acidity in this study (i.e., pH = 2). The kinetic analysis of these particles results yields a reaction rate constant of chloride ions with the triplet state of IC, $^3IC^*$, ~3 orders of magnitude higher than previously reported values in bulk solution. These findings underscore the significance of the synergetic effect of chlorine chemistry and photosensitization in enhancing atmospheric oxidative capacity.

8AC.3

Nitrate-mediated Photooxidation of Green Leaf Volatiles under Cloud/Fog-like vs. Aerosol-like Conditions. Yuting Lyu, Ruihan Ma, Tianye Zhou, Taekyu Joo, Shun Yeung, Cheuk Yi Wong, Yifang Gu, Yiming Qin, THEODORA NAH, *City University of Hong Kong*

Inorganic nitrate and sulfate are prominent components of atmospheric aqueous phases such as fog/cloud droplets and aqueous aerosols. Inorganic nitrate photolysis in atmospheric phases produce a variety of oxidants, which participate in chemical reactions with organic compounds to produce aqueous secondary organic aerosols (aqSOA). Green leaf volatiles (GLVs) are biogenic oxygenated hydrocarbons that can partition into atmospheric aqueous phases and be oxidized by oxidants to form aqSOA. There are several intrinsic differences between fog/cloud droplets and aqueous aerosols, including differences in their concentrations of constituents and ionic strengths, but it is unclear how these differences affect reaction kinetics and aqSOA formation. We report results from our laboratory investigations of the nitrate-mediated photooxidation of four GLVs (cis-3-hexen-1-ol, trans-2-hexen-1-ol, trans-2-penten-1-ol, and 2-methyl-3-buten-2-ol) at different pH, ionic strengths, and sulfate concentrations under conditions mimicking fog/cloud droplets vs. aqueous aerosols. Higher reactions rates were measured under fog/cloud-like conditions. Ionic strength, pH, and sulfate differences had little effect on the reaction rates of the GLVs under fog/cloud-like conditions. In contrast, ionic strength, pH, and sulfate had significant effects on the reaction rates of the GLVs under aerosol-like conditions. Additionally, the reaction rates of the GLVs increased substantially when high concentrations of sulfate were present, thus suggesting that reactive oxidants formed from sulfate photolysis contributed to the increased reaction rates. We also compared the products and the mass yields of aqSOA formed under these different conditions. Our results highlight how intrinsic differences (in this case, concentrations of constituents and ionic strength) between fog/cloud droplets and aqueous aerosols can contribute to differences in pH-dependent aqueous chemistry of organic compounds in atmospheric organic phases, with implications for the composition and mass concentration of aqSOA formed.

8AC.4

Time-Resolved Photochemical Dynamics of Pyruvic Acid in Aqueous Solutions. MIN-HSIEN (TONY) KAO, Conlan Broderick, Jim Walker, Andrew J. Orr-Ewing, Bryan R. Bzdek, *University of Bristol*

Pyruvic acid is an important component of secondary organic aerosol and arises from atmospheric oxidation of isoprene. The photochemistry of pyruvic acid differs significantly at the air-water interface compared to bulk solution or the gas phase. Absorption of UVA radiation and subsequent photoexcitation lead to dimerization and oligomerization processes in water. However, detailed reaction dynamics for this process have not yet been reported. In this study, we explore the photochemical reaction dynamics of pyruvic acid within bulk aqueous solutions across picosecond to microsecond timescales at an excitation wavelength of 345 nm using advanced spectroscopic techniques, including time-correlated single photon counting (TCSPC) and transient absorption spectroscopy (TAS). TCSPC allows measurement of fluorescence lifetimes with ~100-picosecond time resolution, whereas TAS allows observation of excited state absorption and kinetics with sub-picosecond time resolution.

Investigations of fluorescence lifetimes using TCSPC reveal a consistent lifetime (~4.5 ns) for the first excited state (S_1) of pyruvic acid, indicating negligible interaction with the ground-state to form a dimer. Contrastingly, TAS experiments unveil the formation and decay of triplet state pyruvic acid, with kinetics varying with pyruvic acid concentration. These concentration-dependent kinetics suggest the triplet state plays an important role in dimerization reactions. We will also describe ongoing efforts to explore the photochemical dynamics of pyruvic acid within aqueous droplets. Individual picoliter droplets are collimated in a linear quadrupole electrodynamic balance and then spectroscopically interrogated using time-resolved techniques. The results of these picoliter droplet experiments will shed light on the photochemical dynamics of pyruvic acid in microcompartments and will allow comparisons to bulk phase studies.

8AC.5

Multiphase Control of Complex Kinetics in Aqueous Microdroplets.

ALEXANDRA DEAL, Franky Bernal, Alexander Prophet, Richard Saykally, Kevin R. Wilson, *Lawrence Berkeley National Laboratory*

Understanding reaction kinetics in aqueous microdroplets including aerosols and cloud droplets is challenging due to the multiphase nature of these environments. Recent efforts in atmospheric chemistry have led to enhanced efforts in this area, but a complete model of dynamics and kinetics in microdroplets is still under development. Here, we use a stochastic kinetic model of the oxidation of thiosulfate by ozone to examine the multiphase control of a complex reaction mechanism in the microdroplet environment. Previous work has shown that a detailed description of the multiphase dynamics of ozone is crucial for accurate kinetic modeling. We demonstrate that this can also be true for reaction intermediates, implying that complex reaction mechanisms may be impacted by the multiphase nature of microdroplets at several stages. Namely, we find that the thiosulfate oxidation by ozone is sensitive to SO_2 evaporation and its equilibria with HSO_3^- and SO_3^{2-}. To better understand the role of surface activity on reaction kinetics, we employ Deep-UV Second Harmonic Generation (DUV-SHG) spectroscopy to directly probe thiosulfate and sulfite at the air-water interface and quantify their surface affinity. These results show thiosulfate exhibits a strong propensity for the interface with a Gibbs free energy of adsorption of -7.2 kJ/mol while sulfite exhibits negligible surface adsorption.

Finally, we take a closer look at model results, focusing on how each phase (gas, interface, bulk) affects the overall mechanism and product distributions. We find that the primary reaction between thiosulfate and ozone occurs predominantly at the interface while subsequent reaction steps occur predominantly in the bulk. This division is likely true for other atmospherically relevant reaction mechanisms, and we attempt to provide reaction rate/surface activity envelopes which atmospheric scientists can use to screen for reactions with ozone that are likely to occur at the interface, in the bulk, or across phases.

8AC.6

Impact of Temperature on Gas-Particle Phase Transitions and Secondary Organic Aerosol Formation in α-Pinene and Cyclohexene Ozonolysis Systems.

DANIEL GONZALEZ, Yanyu Zhang, Thomas Eckel, David R. Cocker III, *University of California, Riverside*

This work probes the deviations from gas-particle phase transition theories via temperature cycle experiments in α-pinene and cyclohexene dark ozonolysis systems. In these theories, it is assumed that the transition between gas and particle phases is entirely reversible throughout temperature cycles. However, recent studies have shown that aerosol particles can transition from liquid to solid when they reach a specific temperature threshold, significantly impacting partitioning behaviors. The findings from this study unveil the considerable influence of temperature on SOA formation and emphasize the necessity for additional research to explore the role of temperature and particle viscosity in gas-particle phase theories and SOA behaviors.

In the α-pinene system, gas-particle phase transitions demonstrated consistent reversibility throughout repeated temperature cycling (5 – 35°C) over 48 hours. However, in the cyclohexene system, there was an irreversible mass loss after the initial temperature cycle, though consistent reversibility was observed during subsequent cycles. The findings suggest that α-pinene SOA does not undergo a phase change within this temperature range, whereas cyclohexene SOA might become more viscous, impeding partitioning. This is bolstered by compositional (e.g., H:C, O:C) and physical evaluations (e.g., size, density, volatility, viscosity, hygroscopicity). This study highlights the importance of understanding the influence of temperature on SOA, which is essential for accurate modeling of atmospheric processes and air quality management strategies.

8AC.7

The Role of Aerosol Acidity and Buffering Capacity in the Reactive Uptake and Chemical Feedbacks of Gaseous N2O5-Organic Aerosol Systems.

GRAHAM THORNHILL, Luke Monroe, Jack Hall, Ryan Sullivan, *Carnegie Mellon University*

The reactive uptake of trace gases onto aerosols and the resulting changes in aerosol properties such as composition, morphology, and further reactive uptake are heavily affected by aerosol acidity. Aerosol pH, as well as the kinetics of reactive uptake and changes in droplet properties, are difficult to measure continuously and directly due to wide aerosol size distributions, tiny volumes, compositional complexity, and the need for non-ideal thermodynamic calculations. As such, the effect of acidity on aerosol reactive uptake and chemical feedbacks during prolonged multiphase chemistry is not well understood. Using aerosol optical tweezers with its cavity-enhanced Raman spectroscopy and whispering gallery modes to determine chemical information, and calculate aerosol size and refractive index, respectively, we have both developed a method of estimating droplet buffering capacity in inorganic sodium bisulfate droplets as well as observed chemical feedbacks in the uptake of gaseous N_2O_5 in the presence of terpene oxidation products. Through tracking aerosol pH and acid molality in sodium bisulfate aerosol in equilibrium with water vapor we were able to estimate the droplet's effective pKa to be about -0.28, a stark contrast from the system's bulk pKa of 1.99. In other experiments, droplets in the presence of N_2O_5(g) and ????-pinene or limonene formed a new organic phase consisting of organonitrates. The morphology change resulting in this new phase occurs via the amount of organic acid added and the acidification by N_2O_5 hydrolysis or HONO oxidation to HNO3. Raman modes from the products formed by N_2O_5/NO3• oxidation of the new organic phase was also retrieved. These experiments enable measurements of aerosol pH and buffer capacity during ongoing multiphase chemistry involving the N_2O_5-organic aerosol system, characterization of the reaction products from these systems, and determining the controls and feedbacks present in this complex kinetic system.

8CA.1

A New Methodology to Assess the Water Uptake by Organic Aerosols.

NAGENDRA RAPARTHI, Ann M. Dillner, Anthony S. Wexler, *Air Quality Research Center, UC Davis*

Atmospheric aerosols often consist of both organic and inorganic compounds with varying physicochemical properties. Historically, the hygroscopic characteristics of cloud condensation nuclei (CCN) were primarily influenced by inorganic compounds such as nitrates, sulfates, and chlorides. However, with the implementation of emissions controls that have successfully reduced nitrogen and sulfur oxide emissions, there has been a notable shift towards the organic fraction of aerosols assuming a more prominent role. Nevertheless, the organic fraction is considerably more complex than its inorganic counterpart, comprising thousands of individual compounds originating from diverse sources and reaction pathways, each possessing distinct physical and chemical properties. This complexity often poses challenges in establishing a clear correlation between the organic fraction and their hygroscopicity. In this study, we have developed a novel methodology to assess the water uptake of organic aerosols traditionally collected on Teflon filters, thereby providing an opportunity to link the assessed hygroscopicity with organic functional groups (OFGs). Hygroscopic measurements were conducted in the laboratory for Ammonium Sulfate, Sodium Chloride, Glucose, and Malonic Acid, which were collected on 25mm Teflon filters using an Aerosol Generator and Sampler (AGS). Constant Humidity Solutions (CHS) were employed to maintain the Relative Humidity (RH) at 84%, 90%, and 97% in confined chambers. The results are consistent with those reported by the E-AIM model and previous studies utilizing Humidified Tandem Differential Mobility Analyzer (HTDMA) and Electrodynamic Balance (EDB), highlighting the accuracy of this new methodology. This new approach enables the hygroscopicity of filter samples to be assessed along with the chemical composition of the filter samples. Applying this methodology to field and smog chamber samples, enables the linking of their hygroscopicity to composition and OFGs quantified through Fourier Transform Infrared (FT-IR) spectroscopy.

8CA.2

Are We Measuring What We Think We're Measuring? Assessing the ACSM's Sampling Efficiency. Arthur J. Sedlacek, Maria Zawadowicz, Ogochukwu Enekwizu, Ernie R. Lewis, AMIE DOBRACKI, *Brookhaven National Laboratory*

Biomass burning injects 16-34 Tg of particulate matter into Earth's atmosphere each year and is a major source of black carbon (BC) and organic aerosols (OA). In this study we determined the sampling efficiency of the Time-of-Flight Aerosol Chemical Speciation Monitor (ToF-ACSM; Aerodyne) for biomass burning relevant compounds such as, sucrose, levoglucosan, and oleic acid using two different experimental setups. Initially, we examined the sampling efficiency for pure aerosolized particles with electrical mobility diameters of 100, 200, 300, and 400 nm. The second set of experiments evaluated the sampling efficiency for levoglucosan and oleic acid coatings, varying in thickness between 20 and 50 nm on 150 nm BC particles to ascertain if the ACSM effectively samples a diverse range of organic substances, despite variations in their size, chemical composition, and phase state. Our results show that the sampling efficiency is greatest (80-90 %) for uncoated 200 nm sucrose, levoglucosan, and oleic acid particles, whereas the other electrical mobility diameters were sampled less efficiently (60-70 %). In the coated particle experiments, we found that there were no discernible differences in sampling efficiency when the coating thicknesses of levoglucosan and oleic acid varied between 20 and 50 nm. However, we did identify slight differences in mass spectra when comparing the spectra of pure aerosolized particles to the spectra of coated particles, suggesting that in the presence of refractory compounds, the organic components are vaporized differently than pure OA.

8CA.3

Probing Diverse Biomass Combustion Modes through Experiments with a Controlled Atmosphere Cone Calorimeter. Vilhelm B. Malmborg, Ioannis Sadiktsis, Axel Eriksson, Johannes Rex, Dan Madsen, Patrick van Hees, ANDREW GRIESHOP, Joakim Pagels, *Lund University, Sweden*

The composition of biomass combustion emissions depends on both fuel properties and combustion conditions, but few studies have systematically controlled combustion type to explore its influence on emission yields and properties. A controlled atmosphere cone calorimeter is a device that varies multiple combustion parameters during heating and ignition of a fuel sample. Forty experiments were conducted with flat birch wood samples with varied heat flux (HF) and gas flow rate and composition (pure N_2 or air) to generate pyrolysis, and under-ventilated (oxygen-starved) or well-ventilated combustion conditions. During tests, both online aerosol measurements and integrated samples (filters, TEM grids) were collected. Highly distinct particle yields and characteristics were demonstrated across combustion conditions and between test phases. Tests had similar characteristics during the initial pre-ignition 'pyrolysis' phase, but differed greatly during combustion, where the under-ventilated tests show much higher emissions of OA, eBC and especially PAHs (from SP-AMS analysis). Phase-specific OA yields and SP-AMS spectra differ greatly between phases, for example between N_2 pyrolysis and 'pyrolysis phase' (pre-ignition) and combustion-phase emissions. Nontarget analysis via reversed phase LC-high-resolution MS was conducted on methanol extracts from representative test filters for 5 conditions (pyrolysis in N_2 at 3 different heat flux levels and under-ventilated and well-ventilated combustion). The molecular composition from under-ventilated combustion diverges from those from other conditions, which appear more similar. However, the pyrolysis sample at the lowest HF (15 kW m^{-2}) shows an enrichment in hydrophobic compounds (indicated by higher retention times) as well as lower contributions from low mass-to-charge features. We hypothesize that these compounds could be molecular signatures of larger breakdown products of lignin that further break down into smaller molecules at higher combustion/pyrolysis temperatures (higher HF) and may be linked with viscosity/morphology examined in future analyses.

8CA.4

Rapid Nighttime Darkening of Biomass Burning Brown Carbon by Nitrate Radicals Is Suppressed by Prior Daytime Photochemical Processes. CAROLYN LIU-KANG, Laura-Helena Rivellini, Jonathan Abbatt, *University of Toronto*

Brown carbon (BrC) is a type of carbonaceous aerosol, primarily emitted from biomass burning sources such as wildfires. These aerosol particles have significant implications on climate by their ability to absorb light, potentially contributing to warming effects. Due to the expected increase of wildfire activity in the upcoming years, this source of particulate emission is also expected to increase. Oxidative and photochemical aging, however, can change brown carbon's light absorption properties as well as its chemical composition. Therefore, significant uncertainties remain when estimating BrC's contribution to climate effects.

Here, we focused on nighttime oxidative aging by NO_3 radicals of water-soluble wood smoke particles. We also investigated how diurnal effects, such as daytime aging by OH radical oxidation and UV light exposure, can affect the extent of subsequent NO_3 oxidation. We generated in-lab wood smoke by smoldering pine wood, before aerosolizing the aqueous extract into a chamber. Online monitoring of the changes in the optical properties, chemical composition, and size distributions was done with, respectively, an aethalometer, an aerosol mass spectrometer (AMS) and a scanning mobility particle sizer (SMPS). Our results indicate that NO_3 radical oxidation leads to rapid absorption enhancement of our BrC aerosols in both the UV and visible with very low NO_3 mixing ratios. In addition, prior aging by daytime processes inhibits the extent of this nighttime aging process, indicating competitive mechanisms and common reactive entities within the BrC material.

8CA.5

Direct Observation of Increased Aloft Organic Dinitrates and Oxidized Organosulfates from the Southern Great Plains and TRACER Campaign. GREGORY W. VANDERGRIFT, Darielle Dexheimer, Damao Zhang, Zezhen Cheng, Nurun Nahar Lata, Mickey Rogers, ManishKumar Shrivastava, Jie Zhang, Brian Gaudet, Fan Mei, Lindsay Yee, Allen Goldstein, Swarup China, *Pacific Northwest National Laboratory*

Significant knowledge gaps remain regarding the vertically resolved organic molecular-level composition of atmospheric particles due to aloft sampling challenges. To address this, we use a tethered balloon system to collect ground level and aloft (up to 950 m) samples followed by direct sampling high-resolution mass spectrometry to characterize organic molecular formulas (MF). At the Southern Great Plains (agricultural region; April 2022), we show that organic MF uniquely detected aloft were dominated by organonitrates (139 MF; 54% of all uniquely detected aloft MF). Organonitrates that were uniquely detected aloft featured elevated O/C ratios (0.73±0.23) compared to aloft organonitrates that were commonly observed at the ground level (0.63±0.22). Unique aloft organic molecular composition was positively associated with increased cloud coverage, increased aloft relative humidity (~40% increase compared to ground level), and decreased vertical wind variance. Furthermore, 29% of extremely low volatility organic compounds in the aloft sample were truly unique to the aloft sample compared to the ground level, emphasizing potential aloft oligomer formation at higher altitudes. At this location, we hypothesize that aqueous phase transformations and vertical wind variance may be key variables affecting the molecular composition of aloft organic aerosol. We furthermore characterized aloft organic MF from the TRACER campaign (urban atmosphere; June 2022). For select days, we directly observe increased aloft organic dinitrates compared to ground level, whereas oxidized organosulfates dominated aloft samples for other events. This effort is ongoing, but via leveraging aerosol chemical speciation measurements and remote sensing data, we currently hypothesize that the increase in aloft organic dinitrates results from nighttime biogenic SOA formation, consistent with previous aircraft campaigns in polluted airmasses. Overall, these efforts highlight the inherent value in assessing organic molecular composition of atmospheric particles from a vertically resolved perspective and offer predictive metrics for the occurrence when atmospheric heterogeneity may occur.

8CA.6

Unraveling Urban vs. Wildfire Influences in Aerosol Properties over Thailand during Airborne and Satellite Investigation of Asian Air Quality (ASIA-AQ) Campaign. SAYANTEE ROY, Elizabeth Wiggins, Francesca Gallo, Michael Shook, Josh DiGangi, Glenn Diskin, Carolyn Jordan, Edward Winstead, Viphada Boonlerd, Luke Ziemba, Richard Moore, *NASA Langley*

The NASA Airborne and Satellite Investigation of Asian Air Quality (ASIA-AQ) flight campaign conducted in February and March 2024 aimed to enhance understanding of air quality dynamics and pollution transport in Southeast Asia. Utilizing a multi-perspective approach combining aircraft, satellite, and ground-based data, the campaign focused on major cities in the Philippines, South Korea, Thailand, and Taiwan. The deployment of the NASA DC-8 aircraft facilitated real-time measurements of aerosol properties, trace gases, and meteorological parameters. This study presents a comprehensive characterization of aerosol microphysical, chemical, and optical properties, along with gaseous composition, in two contrasting locations within Thailand: Chiang Mai and Bangkok. Chiang Mai, known for heavy biomass burning from forest fires and agricultural waste burning during the dry season (February-April), contrasts with Bangkok's urban pollution sources. In this study, analysis of particle number size distribution (PNSD) and optical properties are utilized to distinguish between urban and wildfire influences, with gaseous constituents serving as markers for biomass burning emissions. The results highlight distinct signatures of aerosol properties and gaseous composition indicative of biomass burning in Chiang Mai, contrasting with urban pollution characteristics observed in Bangkok. Further, the analysis integrates meteorological data to assess the influence of local conditions and potential pollution transport pathways, contributing to a holistic understanding of air quality dynamics in the region. The findings from this study not only enhance knowledge of local air quality but also highlights broader discussions on regional pollution impacts, thus, facilitating informed decision-making for air quality management strategies and improving air quality in the region.

8CA.7

Ambient Dust, Entrained Soil and the Toxicity of Wildfire Smoke in a Changing Climate. BROOKE L. HEMMING, Anne E. Barkley, *U.S. Environmental Protection Agency*

The changing intensity and scale of wildfires 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 variables that determine the toxicity of the smoke. Among the climate-sensitive variables are those affecting the primary carbon content of smoke particles, the nature and rates of in-plume photochemical oxidation processes, and the altitudes and transit periods of smoke plumes. Climate change-induced impacts include altered fuel bed vegetation species composition and meteorological patterns that control fuel moisture and burning conditions. Climate also influences the entrainment of soil and ambient dust that can change the 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 oxidized particle-bound species that have clear health implications for exposed human populations. The addition of soil entrained from the fuel bed of a fire and dust present in the atmosphere downwind can provide reactive and/or catalytic surfaces which may amplify the oxidation rates of particle-bound organic carbon species. This presentation will provide an overview of the theoretical climate change impacts on wildfire BrC/soil/dust photochemistry and explore the potential respiratory toxin generation process based on a synthesis of available scientific literature. Suggestions for additional research that can deepen our understanding of the process will be offered. This work is intended to improve understanding of the potential influence of the changing climate 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.

8CE.1 – INVITED

Field Observations of Organic Contaminants at the Coast and Studies of Their Photo-induced Degradation Pathways and Kinetics in Sea Spray Aerosols. JONATHAN SLADE, *University of California San Diego*

Emerging contaminants such as organic ultraviolet filters (UVFs) in sunscreens, and chemical residues in plastics and rubber, are commonly found in the surface layer of the ocean. Here, they can more easily transition to the air in gas and particulate forms, potentially through sea spray aerosol (SSA). In this presentation, I'll discuss our research on analyzing these chemicals in aerosols and seawater collected in the San Diego coastal region, as well as how they undergo chemical transformations and degrade when exposed to light, with comparisons between SSA mimics and bulk solutions.

Our results show that compounds representative of personal care products, like sunscreen, are more prevalent in coastal aerosols in San Diego during periods of onshore wind. This observation indicates the need to understand how these chemicals age in SSA. By using model SSA systems mixed with specific organic pollutants, we demonstrate that sea salt can boost their oxidation rates initiated by hydroxyl radicals, yet can also inhibit or even entirely prevent their degradation via photosensitization.

Furthermore, our studies indicate that direct and indirect photolysis happens at faster rates in SSA particle mimics than in bulk synthetic and real seawater solutions. Despite having shorter chemical lifetimes in the aerosol phase, these compounds tend to transform into byproducts that might be more toxic than the original molecule. This has significant implications for pollutant transport and air quality in coastal areas.

8CE.2

Partitioning of ROS from Lipid Film to DOS Film through Air. ZHENDUO YAO, Glenn Morrison, *University of North Carolina at Chapel Hill*

The presence of peroxides, ozonides and other reactive oxygen species (ROS) has been observed on indoor surfaces. Initiated by ozone and possibly other oxidants, ROS has been shown to form on surfaces coated with skin lipids and cooking oils. Models predict that some of the ROS formed have physico-chemical properties that allow them to partition from indoor surfaces to aerosols. This process can thereby lead to inhalation exposure of indoor-generated ROS, and the possibility of deposition deep in the respiratory system. In this research, we explored the potential for ROS formed on indoor surfaces to partition via gas-phase transport to a separate condensed phase. A simulated surface lipid mixture (SLM), comprising squalene, fatty acids, triglycerides, and cholesterol was allowed to oxidize naturally on glass plates exposed to laboratory air for 5 days. After exposure, a second glass plate, coated with a thin layer of dioctyl sebacate (DOS), was placed over the SLM coated plate for 1 day. The SLM and DOS coated sides faced each other and were separated by a 1.0 mm air gap. The short distance allows for rapid transfer of semivolatile compounds from the aged SLM film to the DOS receptor film. The coatings on each plate were extracted and the ROS concentrations were measured using a colorimetric assay based on ferrous ion oxidation and xylenol orange as an indicator (FOX2 method). Preliminary results indicate that approximately 14% of ROS that forms in SLM partitioned to the receptor film. These experiments demonstrate that ROS formed within a reactive lipid mixture can partition from surfaces, through air to a separate condensed phase. Therefore, a considerable amount of ROS that forms on indoor surfaces should also be able partition to airborne particles.

8CE.3

Photo-initiated Degradation Kinetics of the Organic UV filter Oxybenzone in Solutions and Aerosols: Impact of Salt, Photosensitizers, and the Medium. ADAM COOPER, Alexis Shenkiryk, Maya Morris, Tessa Tafuri, Jonathan Slade, *University of California San Diego*

Organic UV filters in sunscreens, such as oxybenzone (BP3), are concentrated and persistent pollutants in seawater because of their broad use and resistance to photolysis. BP3 is hydrophobic and suspected to undergo ocean-to-air transfer via sea spray aerosol (SSA), potentially leading to different reactivity in the aerosol phase compared to bulk seawater. This study contrasts the photo-initiated degradation reactions and kinetics of BP3 in artificial seawater mixes and real seawater with those in SSA mimics comprised of NaCl and a model photosensitizer, 4-benzoyl benzoic acid (4-BBA). Pure, binary, and ternary mixtures of BP3, NaCl, and 4-BBA were studied in the dark and irradiated to isolate the impacts of salt and the photosensitizer on BP3 degradation. Experiments were conducted in a quartz cuvette exposed to solar-simulated light and analyzed via UV-VIS spectroscopy for bulk solutions and an oxidation flow tube reactor equipped with broadband UV lamps for aerosols, analyzed via extractive electrospray ionization time-of-flight mass spectrometry (EESI-TOF). Results indicate significant differences between the solution and aerosol phase effective photolysis rates (J_{eff}) scaled to equivalent solar exposure times, with much faster degradation observed in the aerosol phase ($J_{eff} \approx 10^{-3}$-10^{-2} s^{-1} or $t_{1/2}$<10 min) than in bulk solutions ($J_{eff} \approx 10^{-6}$ s^{-1} or $t_{1/2}$>1 day) in all mixtures. The photosensitizer enhanced BP3 photodegradation in both environmental phases but more so in solution compared to mixtures with salt or all three components, whereas BP3 photodegradation was enhanced the most in the presence of salt in the aerosol phase. The faster kinetics in the aerosol phase are consistent with previous studies demonstrating greater photodegradation in aerosols due to morphology-dependent resonances and a decreased solvent-cage effect compared to bulk solutions. High-resolution molecular identification of transformation products via Orbitrap liquid chromatography tandem mass spectrometry (LC-MS/MS) showed an enhanced generation of reduced forms of BP3, notably benzophenone, alongside smaller fragmentation products, such as benzoic acid and benzaldehyde, in the aerosol phase compared to the bulk, which enhances the aerosol's toxicity (i.e., predicted LD50 for rats using EPISTAR). These results demonstrate the stark differences in photodegradation between the bulk and aerosol phases of a prevalent and toxic UV filter and indicate that photo-induced reactions of BP3 in SSA may be relatively more important than in seawater concerning its effects on particle toxicity.

8CE.4

Wastewater Treatment Plants as Major Sources of Atmospheric PFAS and Microplastics. AIDAN MCCLURE, Kanchana Chandrakanthan, Paul Westerhoff, Matthew Fraser, Pierre Herckes, *Arizona State University*

Per and Polyfluoroalkyl Substances, or PFAS, are emerging pollutants of concern, both due to their nature as "Forever Chemicals" and their severe health effects at trace levels. Recently, the US EPA passed legislation to limit certain PFAS, such as perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS), to 4 parts per trillion in drinking water. Drinking water plants largely rely on natural water sources, meaning that the chain of PFAS pollution must be broken in order for safe levels of PFAS to be achievable. Atmospheric emissions are the least understood process by which PFAS transport into the environment, owing to the difficulty of sampling, measurement, and source attribution. One important mechanism by which PFAS enter the atmosphere is sea spray, as recent studies have demonstrated. Analogous to sea spray, air bubbles bursting at the surface of aeration basins at wastewater treatment plants (WWTP) have the potential to emit large amounts of PFAS, along with other pollutants, to their surroundings. Of these other pollutants, microplastics are of particular concern, due to their ubiquity and potential to adsorb chemicals of concern, including PFAS, further complicating their transport.

Here, we present results from a study quantifying the emissions of PFAS and microplastics from aeration basins at a WWTP. Samples were collected daily using a high volume polyurethane foam (PUF) air sampler over two weeks at a WWTP, with particle phase PFAS and microplastics being collected on a frontal quartz fiber filter and gas phase PFAS being collected on XAD-4 impregnated PUF foams. PFAS were detected in all phases and all samples at concentrations substantially higher than in ambient air. Microplastics were found in all collected samples, ranging from 3.4 to 5.2 microplastics/m^3, which is an order of magnitude higher than in urban ambient air.

8CE.5

Particle Emissions from Electric Vehicle Fast Charging Stations. Yuan Yao, Muchuan Niu, Haoxuan Chen, Qiao Yu, Qingyang Wu, Michael Jerrett, YIFANG ZHU, *University of California, Los Angeles*

To combat climate change, policymakers around the globe have committed to accelerating the transition to electric vehicles (EVs). This unprecedented large-scale transportation electrification will necessitate the establishment of a vast network of EV fast chargers worldwide. Here we report that the power cabinet at Direct Current Fast Charging (DCFC) stations emit fine particulate matter ($PM_{2.5}$), which are associated with increased morbidity through the life course and premature death. We collected 24-hr integrated filter samples from 50 DCFC stations across 47 cities in Los Angeles County, California, and found that $PM_{2.5}$ concentrations were between 7.3 to 39.0 µg m^{-3}. To understand the emission process of these particles, we tested a series of potential mechanisms for particle emissions at DCFC stations. We conducted extensive field measurements for real-time $PM_{2.5}$ mass concentration, particle size distribution, and other pollutants, as well as EV charging activities, and found that these particles are mainly in the sub-micrometer size range (0.5-1.0 µm). Currently, no emission standards exist for DCFC. Without regulation or interventions, these particles could potentially expose nearby communities, EV users, and the workforce operating these facilities to high levels of $PM_{2.5}$, potentially leading to widespread health consequences.

8CE.6

Investigating the Effectiveness of a Ventilation Intervention on Air Quality in a Commercial Kitchen. Yinxgi Lu, Tyler Cargill, Zhiyao Li, Jay R. Turner, JENNA DITTO, *Washington University in St. Louis*

Emissions of gas- and particle-phase organic compounds from commercial kitchens can impact both indoor and outdoor air quality. Indoors, these emissions present a major source of occupational exposure for kitchen staff and other building occupants. We measured volatile organic compounds (VOCs), particulate matter, and surface-sorbed gases and particles in a campus building that housed both a ground-floor commercial kitchen and a second-floor office space. VOCs were chemically speciated with a proton transfer reaction mass spectrometer across ions with formulae $C_{1-15}H_{4-33}O_{0-5}N_{0-3}S_{0-3}Cl_{0-3}^{+}$. We also measured $PM_{2.5}$ mass concentrations and CO_2 mixing ratios with low-cost sensor devices on both floors of the building. At the same time, we deployed clean glass surfaces near the cooking area to chemically speciate surface-sorbed compounds via liquid chromatography with high-resolution mass spectrometry. Measurements were made before and after a ventilation upgrade in the kitchen. The goal of the ventilation intervention was to improve range hood capture efficiency and reduce the levels of fugitive cooking emissions escaping into the building's air at-large, causing discomfort and disruption to staff in the adjacent office spaces. We track tracers of oil thermal decomposition (focusing on carbonyls) and meat cooking (focusing on tracers from pork and beef as the main meats cooked at the barbeque-based kitchen, including a range of carbonyls, carboxylic acids, alcohols, and a subset of sulfur- and/or nitrogen-containing ions) as a function of the variable ventilation conditions. We also more broadly characterize the consistent contributions of cleaning and human emissions in the space. Together with measured particle concentrations and speciation of surface-sorbed species, we assess the air quality impacts of this ventilation upgrade.

8HR.1

Dependence of Aerosol-borne Influenza A Virus Infectivity on Relative Humidity, Aerosol and Air Composition. GHISLAIN MOTOS, Aline Schaub, Laura Costa Henriques, Celine Terrettaz, Christos Kaltsonoudis, Irina Glas, Klein Liviana, Nir Bluvshtein, Beiping Luo, Kalliopi Violaki, Marie Pohl, Walter Hugentobler, Ulrich Krieger, Spyros N. Pandis, Silke Stertz, Thomas Peter, Tamar Kohn, Athanasios Nenes, Shannon David, *EPFL, Switzerland*

Influenza causes 250’000 to 500’000 deaths and 3 to 5 million cases of serious illness each year and is arguably the most feared potential public health emergency globally. Aerosol experiments investigating the impact of relative humidity (RH) and aerosol matrix composition on the infectivity of influenza A virus (IAV) have suffered a lack of standardization and characterization of important parameters, leading to large discrepancies in the results reported in the literature. Surprisingly, the composition of the air surrounding the virus-containing particles only became a research focus area in very recent years. We developed a novel biosafety aerosol chamber equipped with state-of-the-art instrumentation for bubble-bursting aerosol generation, size distribution measurement, and condensation-growth collection to minimize sampling artifacts when measuring virus infectivity in aerosol particles. Using this facility, we investigated the effect of RH in very clean air without pH-modifying trace gases (except ~400 ppm CO2) on the preservation of IAV infectivity in saline aerosol particles. We characterized infectivity in terms of 99%-inactivation time, t99, a metric we consider most relevant to airborne virus transmission. The viruses remained infectious for a long time, namely t99 > 5 h, if RH < 30% and the particles are effloresced. Under intermediate conditions of humidity (40% < RH < 70%), the loss of infectivity was most rapid (t99 ≈ 15-20 min, and up to t99 ≈ 35 min at 95% RH). We added sucrose to our aerosolization medium and observed a modest protection of IAV at intermediate RH (55 %). Through a combination of chamber experiments and modeling, we tested the potential of acidic vapors to condense on aerosol particles, decrease their pH and inactivate the IAV they contain. We discuss the potential for humidification and acidification as possible intervention strategies for preconditioning air to minimize the risk of IAV transmission in indoor environments.

8HR.2

Mucin Protects Influenza a Virus from Decay in Evaporating Droplets. JIN PAN, Nisha Duggal, Seema Lakdawala, Nicole C. Rockey, Linsey Marr, *Virginia Tech*

The stability of influenza virus in respiratory particles is a function of relative humidity (RH), and this relationship appears to depend on protein content, which accounts for 20-50% of dry weight of the particles. The objective of this research was to investigate the stability of influenza A virus in evaporating 1-µL respiratory droplets at different concentrations of mucin, the most abundant protein in respiratory fluids. The virus remained relatively stable at mucin concentrations of both 0.1% and 0.5% in droplets of phosphate-buffered saline (PBS) over the 4-hour duration of the experiment at 20%, 50%, and 80% RH, with a maximum decay of 1.5 $\log_{10}$, whereas the virus decayed by at least 3 $\log_{10}$ to the detection limit in pure PBS droplets after 4 hours at 50% and 80% RH. The protective effect was slightly stronger with 0.5% mucin than with 0.1% mucin. We further examined droplet morphology and localization of fluorescently labeled virions in evaporating droplets at various RH through confocal microscopy. Confocal images suggested that at 20% and 50% RH, the addition of mucin promoted the formation of feather-like, dendritic crystals, around which virions were co-localized with mucin. In the absence of mucin, isolated and square crystals formed. Virions were either in direct contact with the isolated crystals or scattered on the substrate surface. We observed that 0.5% mucin mitigated the coffee-ring effect and thus homogenized the distribution of virions in evaporating droplets. At 80% RH, there was no morphological difference between virus-laden droplets with and without mucin, but virions were still co-localized with mucin. These findings suggest that the co-localization of mucin and virions in evaporating droplets may reduce the exposure of virions to high concentrations of salts near salt crystals and other environmental stressors near the coffee ring in respiratory droplets, thereby maintaining virus stability.

8HR.3

Characterizing the Transient Emission of Particles and Gases From Single Puff of Electronic Cigarette Smoke. KAPIAMBA KASHALA FABRICE, Yue-Wern Huang, Yang Wang, *University of Miami*

The prevalence of electronic cigarettes (ECs) has escalated concerns about potential health risks associated with the emitted aerosols and gas species. Herein, we utilized high-time-resolution characterization systems to study the transient emission of aerosols and gases emitted from a single puff of EC smoke. First, we used the Differential Mobility Spectrometer (DMS500) to capture the transient particle size distribution (PSD) of EC aerosols from various brands (JUUL, VOOPOO, VUSE) under controlled conditions, including puff duration, EC power, and e-liquid composition. Significant variations in PSD were observed under different EC operating conditions, predominantly in the size range from 5 nm to 800 nm and a total number concentration in the range of 108 to 1010 particles/cm3. Smaller particles, which are more likely to deposit in the deeper respiratory system were generated particularly in shorter puff durations (2 s). Using the PSDs, we estimated the deposited dose of aerosols in different regions of the respiratory system using the ICRP deposition model. Second, we measured CO2, NOx, CO, and unburned hydrocarbons post-puff and compared these levels against the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs). We found that while CO2 and NOx levels remained within safe limits (with peaks values 880 ± 102 ppm and 3.9 ± 0.7 ppm, respectively), CO levels (with a peak value of 905 ± 50 ppm) exceeded OSHA thresholds by 5 folds when compared to the adjusted 8-hour workday average PEL, highlighting potential safety concerns. The findings advocate for further research to understand the intricate dynamics of EC aerosol generation and evolution. Overall, this study demonstrated the complexity of EC emissions and the necessity for standardized measurement methods to accurately assess their health implications.

8HR.4

Effects on Carbonyl Formation from Addition of Vanillin to Electronic Cigarette Vape Liquids. NICHOLAS ROBERTSON, Haylee Hunsaker, Elizabeth Chiu, Tran Nguyen, *University of California, Davis*

Electronic cigarettes (e-cigarettes) have become one of the most popular forms of nicotine consumption in recent years. Various flavoring chemicals are added to the vaping solution (e-liquids) to make the vaping experience more enjoyable, especially to adolescents. To limit adolescent usage, the FDA has placed a ban on flavoring chemicals in refillable e-cigarettes. Despite this, flavors are still present in disposable e-cigarettes. The mechanisms in which these flavorant chemicals affect the chemistry of the vaping process is still not fully understood. This work focuses on studying the effects of vanillin when used in three nicotine-containing e-liquids: an acid free solution (Free base nicotine) and Benzoic and Lactic acid containing nicotine salt e-liquids. Collected aerosols were analyzed via Liquid Chromatography coupled High Resolution Mass Spectrometry (LC-HRMS). Our results show that the addition of low concentrations of vanillin to these e-liquids decreases the production of most carbonyl emissions quantified in this study. Multiple carbonyl compounds are formed via reactive oxygen species chemistry and of these species (methylglyoxal, lactaldehyde, etc.) showed a decrease upon addition of vanillin. This data indicate that vanillin may have antioxidant properties that could be protective to vape users. In contrast, some carbonyls formed through thermal degradation (acrolein and propionaldehyde) increased upon addition of vanillin. Higher concentrations of vanillin showed an increase in carbonyls similar to the concentrations of the flavor free e-liquid or greater. Thus, vanillin cannot be definitively considered a beneficial additive to e-cigarettes, especially due to concerns over the toxicity of the vanillin itself, but this work shows that vanillin alters the chemical processes that produce toxic emissions in e-cigarettes.

8HR.5

Photochemical Aging of Gasoline Car- and Wood Combustion-Emissions Increase Adverse Effects in Air-Liquid Interface (ALI) Exposed Human Lung Cells. Svenja Offer, Hendryk Czech, Sebastiano Di Bucchianico, Mathilde Delaval, Sebastian Öder, Jana Pantzke, Johannes Becker, Anja Huber, Anni Hartikainen, Pasi Jalava, Mika Ihalainen, Pasi Yli-Pirilä, Olli Sippula, RALF ZIMMERMANN, Consortia ULTRHAS, Team aeroHEALTH, *Mass Spectrometry Centre;Rostock University/Helmholtz Munich*

Emissions from traffic and residential wood combustion (RWC) substantially contribute to toxic particulate matter (PM2.5). In this study, we compare toxicological profiles of fresh and aged RWC-(combustion of spruce logs in a modern chimney stove) and car-emissions (dynamometer operated EURO 6d gasoline car). A flow tube reactor was used for photochemical aging of the emissions (~2 days OH.-exposure equivalence). For RWC-experiments, mice were exposed 3-times to fresh and aged RWC-emission aerosols for 4 hours. Simultaneously, murine macrophages were exposed at the air-liquid interface (ALI). For the aerosol-mediated toxicity, inflammatory, cyto- and genotoxic effects were as-sessed on the functional-, transcriptomic- and proteomic-level. Chemical/physical aerosol properties showed high re-producibility between experiments. Aging slightly increased particle mass but caused distinct changes in the particle chemical composition (e.g., in polycyclic aromatic hydrocarbons (PAHs), oxygenated-PAHs and nitrophenols). Ageing led to a drastic decrease in PAH-concentrations and a net increase in oxygenated-PAHs and nitrophenols. Toxicity-related outcomes were observed in vivo and in vitro after the exposure to either fresh (mild effects) or aged RWC-emissions (strong effects). At functional level, we found induced DNA-breaks in cells of the bronchial alveolar lavage as well as in RAW264.7-murine macrophages that have been exposed to fresh, but especially to aged RWC-emissions. No inflammation was observed in mice after the exposure to fresh RWC-emissions while aging of RWC-emissions led to a clear inflammatory response. For the EURO 6d car, the installed particle filter is precipitating particles with a very high efficiency. Accordingly, the fresh emissions only have a very small adverse impact on ALI-exposed human lung cells (A549/Beas2B). In the PEAR-aged emission, however, high concentrations of secondary particles are formed and reac-tive oxygenated species are present causing a strong increase of the observed toxic effects. Thus, the current emission control devices are not yet addressing secondary aerosol formation potential appropriately.

8HR.6

Size Distribution, Chemical Composition, and Source Contributions of Underground Coal Mine Dust. XIAOLIANG WANG, Mohammadreza Elahifard, Bankole Osho, L.-W. Antony Chen, Judith Chow, John Watson, Behrooz Abbasi, *Desert Research Institute*

Determination of size distributions, chemical compositions, and source contributions of respirable coal mine dust (RCMD) in mining environments is important for health effect assessment and dust control. This study collected source and ambient samples from an underground coal mine and conducted detailed chemical speciation. The effective-variance chemical mass balance (EV-CMB) model was used to apportion RCMD and respirable crystalline silica (RCS) contributions from coal dust, fire suppression limestone dust, rock strata particles, diesel engine exhaust, and intake air.

RCMD concentrations vary significantly within the mine with several locations exceeding the 1.5 mg/m3 permissible exposure limit. The mass size distributions are similar to those measured over a decade ago, with a mass median aerodynamic diameter of ~10 µm and most mass in the size range >1 µm. Among the three locations with the highest RCMD concentrations, limestone dust contributed ~80% to the RCMD mass in the tailgate and return air, while coal dust contributed 51% to the RCMD mass at the longwall face. Intake air dominated the RCMD mass at locations with low concentrations, indicating that these locations were effectively ventilated by intake air. Diesel exhaust is a minor contributor to RCMD mass at most locations. Limestone and rock strata are the main sources of RCS, supporting the concerns for more RCS generation due to the more powerful mining tools cutting more into rock strata.

8HR.7

Tracking Tire Wear Particles: Overhyped or Understudied? MOLLY J. HAUGEN, Siriel Saladin, Phillipp Buhler, David O'Loughlin, Stefan Schlafle, Chiara Giorio, Adam M Boies, *University of Cambridge*

The ubiquity of tires and known macroscopic wear rates has led to a growing concern of tire wear particles as a source of PM10, PM2.5 and ultrafine particles. The wear of tires as a source of airborne pollution is still poorly understood. This study details the dedicated measurements of tire wear nanoparticles from a dedicated rotating drum system at Karlsruhe Institute of Technology.

We examine the generation of nanoparticles generated from tire and road interactions, with a focus on two key aspects: (1) replicating real-world conditions in a controlled environment for particle generation, and (2) analysing the collected particles through both online and offline techniques. In order to generate realistic wear patterns, third body particles were used in a standardized laboratory tire testing facility across dynamic and static speed and load profiles. The findings indicated that milled stone dust as a third body particle significantly disrupted the nanoparticle size range, complicating the differentiation between tire-based and third-body-based nanoparticles. However, using sand as a third body particle, the interference showed comparatively lower background noise within the nanoparticle region. Here, steady-state cycles were employed to discern the relationships between force events and nanoparticle generation which were compared to analyses over an entire dynamic drive cycle. The steady-state cycles revealed that high lateral forces (>2 kN) yielded the highest nanoparticle concentrations, surpassing background levels by over two orders of magnitude. Whereas the drive cycle trials indicated that approximately 70% of emitted nanoparticles throughout the entire drive cycle were semi-volatile emissions, likely originating from vaporization events. ICP-MS results confirmed the presence of tire-related elements in the nanoparticle region, but definitive attribution to tire or road surface remains a challenge for the field. This study underscores the complexities inherent in generating, collecting, and assessing submicron tire wear particles, laying the groundwork for addressing uncertainties and refining non-exhaust tire emission methodologies.

In order to place tire emissions into context, we found a diversity of reported emissions found in secondary literature. Therefore, we analysed all known tire wear emission factors in primary research. Average and median values of 1.7 mg/vkm and 0.2 mg/vkm, respectively, were found for PM10 solely attributed to tire wear from light-duty vehicles (excluding road wear and resuspension). Notably, these emission rates are substantially lower than broadly cited and accepted factors in secondary literature, including USA and EU recommended emissions factor with an average and median of 6.5 and 6.1 mg/vkm, respectively. The discrepancy between primary and secondary literature appears to have arisen from misunderstandings due to different and unclear definitions for tire wear in combination with miscitations and a selection bias. Currently accepted mass-based emission factors for airborne tire wear need revision, including those from the United States Environmental Protection Agency and the European Environment Agency. Directly emitted tire wear PM10 appears to be a lower source of air pollution than widely stated by academia and governments.

8IM.1

Development and Testing of Methods for the Continuous Measurement of the Concentration and Composition of PM0.1. Georgia Argyropoulou, Kalliopi Florou, Andreas Aktypis, Angeliki Matrali, Damianos Pavlidis, SPYROS N. PANDIS, *University of Patras*

Ultrafine particles (diameter less than 100 nm) can translocate to sensitive organs of the human body (e.g., brain) and are thus primary suspects for enhanced negative health effects on humans. Measuring the chemical composition and physical properties of ultrafine particles continuously and accurately is particularly challenging because of their typically low mass concentration ($PM_{0.1}$) and susceptibility to interference from larger particles during the measurement processes. The few past $PM_{0.1}$ chemical composition studies have used cascade impactors. However, this method for $PM_{0.1}$ mass concentration measurement offers low temporal resolution, demands substantial labor, and its results might be affected by larger particles which have significantly more mass.

The Aerodynamic Aerosol Classifier (AAC, Cambustion) has the capability to function as a low-pass separator with selectable cut-off. We used the AAC, to separate PM0.1 from larger particles, followed by instruments that provide continuous composition measurements. An SP^2XR (Droplet Measurement Technologies), for continuous black carbon measurements, a Xact 625i (SailBri Cooper, Inc)., for semi-continuous multi-metals measurements and a High-Resolution Time of Flight Aerosol Mass Spectrometer (HToF-AMS, Aerodyne Research Inc.), for $PM_{0.1}$ organic aerosol, particle density and source-apportionment analysis. The AAC was also combined with a Scanning Mobility Particle Sizer (SMPS) to provide information about the $PM_{0.1}$ density and shape factor.

Ambient $PM_{0.1}$ characterization measurements were conducted in different seasons in a suburban area in Greece. Most of the $PM_{0.1}$ (around 70%) was organic, with sulfates also representing a significant fraction. Black carbon contributed 5-10% on average, while the most prominent elements were Ca, K, Cl, Br, Fe, Zn and Ti. The temporal variation of concentrations, composition, and sources have been analyzed and will be discussed.

8IM.2

A Beta Attenuation System for Mass Determination of Filter-Based Aerosol Samples. JULIAN PROBSDORFER, Emily Macqueene, Jack Kodros, Christian L'Orange, John Volckens, *Colorado State University*

Beta attenuation is a reliable, accurate method for aerosol mass monitoring although it is historically limited to large, stationary, high-volume sampling systems. The goal of this work was to develop a laboratory beta-attenuation system for quantifying mass loading on time-integrated filters collected using low-flow (personal) samplers. This system uses a 12mm effective diameter scintillator, a 37MBq C^{14} source, and is automated with a LabView data-acquisition system. Initial system optimization evaluated the effects of filter size, beam diameter, air gap between the source and detector, temperature, pressure, and relative humidity – all of which had varying degrees of influence on the attenuation measurement. We then developed linear models to correct for this variation. The resultant models, which accounted for mass fluctuations up to 19µg/cm^2 were highly linear ($R^2 = 0.99$). Minimizing the air column is most beneficial to improving method detection limit, but a gap is unavoidable due to the need to be able to move filters in and out of the system. By applying our models to a 200-s measurement period, we achieved a lower limit of detection (LLD) of 33µg for a 37mm filter, and 3.5µg LLD for a 12mm filter - equivalent to sampling in a 2.4µg/m^3 environment for a 24-hour sample at 1L/min. Additional refinement such as increasing the activity of the C^{14} source and optimizing the scintillator's measurement area should allow for further reduction in the LLD and ability to measure smaller filters. With continued development, we expect that this system could out preform gravimetric analysis of miniature air sampling filters resulting in a sub-microgram LLD in the next generation of wearable aerosol sampling devices.

8IM.3

Automated Droplet Freezing Assay System: Investigating Soil and Biogenic Particle Ice Formation. NURUN NAHAR LATA, Gourihar Kulkarni, Sarah Williams, Mickey Rogers, Swarup China, *Pacific Northwest National Laboratory*

In the atmosphere, ice nucleation (IN) is the process through which water vapor transforms into ice crystals within clouds, a fundamental yet intricate phenomenon with significant implications for weather and climate. IN influences cloud microphysics, precipitation, and climate dynamics, particularly in mixed-phase clouds containing both supercooled liquid water droplets and ice particles, which affect cloud lifetime and radiative properties. Clouds at warmer temperatures (> -15°C) are highly sensitive to the presence of ice nucleating particles (INP), such as complex soil dust or biogenic particles. Freezing assay systems are commonly used in the community to study warm temperature freezing. However, traditional droplet freezing assays rely on manual dispensing, introducing variability and large uncertainties in estimating heterogeneous ice nucleation rate coefficients (J_{het}). We developed a novel system that integrates an automated droplet dispensing unit, Nanodroplet Processing in One Pot for Trace Samples (NanoPOTS) with a freezing assay system, achieving droplet volumes with 97% accuracy, by improving uncertainty estimation in J_{het}. This system will measure the droplet freezing assay with high accuracy and seamlessly integrate with downstream analytical techniques, offering a powerful tool for researchers in atmospheric science and biogeochemistry. We will present preliminary results from this novel system to the IN properties of soil and biogenic particles. It enables subsequent multi-modal microscopy and mass spectrometry characterization of particles, enhancing our understanding of IN mechanisms and their impacts on weather and climate.

8IM.4

Investigations of Particle Hygroscopicity using High Purity Aerosolization and Condensation Particle Counting. DEREK OBERREIT, Michael Walker, Jikku Thomas, *Kanomax FMT, Inc.*

The semiconductor industry is experiencing growing concern over defects formed by precipitation of particle precursor material in process chemicals, which is likely introduced to the wafer through the evaporation of droplets remaining after a spin dry process using high purity process chemicals. Nebulization of process chemicals and subsequent condensation particle of the aerosol particles formed after evaporation (Aerosolization+CPC) has been demonstrated to correlate with liquid borne wafer defects. When coupled to a process chemical source, this method also facilitates real-time monitoring of the process chemical to anticipate process disruptions.

While this method can provide insight to the concentration and threshold size of particles formed after droplet evaporation, it does not provide information about how these particles may be affected by ambient vapor. Prior research has quantitatively investigated hygroscopic growth of aerosol particles composed of various materials. For particle sizes below 10 nm, high-purity particle generation using a tube furnace is an effective method, however, it is limited to materials that do not decompose under temperatures required for sufficient evaporation/sublimation necessary to form aerosol particles.

In this work, we describe a system and method to qualitatively infer the hygroscopicity of particles formed through aerosolization of ultrapure water mixed with low concentrations of hygroscopic materials with varying water activity. The net particle concentration of these particles are measured using a water-based and butanol-based CPC where the difference between detected concentrations provides insight into the hygroscopicity of these particles. Our measurements show that for some materials, hygroscopic growth does not correlate with bulk water activity of the material.

8IM.5

Advancing Planetary Climate Science with the Planetary Cloud Aerosols Research Facility (PCARF). MIKE PAUKEN, Luca Valdarno, Marcel Veismann, Dejian Fu, Joseph Salazar, Richard Flagan, Will Cantrell, *Jet Propulsion Laboratory, Caltech*

Clouds and aerosols play critical roles in a planet's climate and weather systems. They affect the distribution of heat and energy, which influence temperature, precipitation patterns, and atmospheric circulation. By studying these components through atmospheric modeling, in situ measurements, remote observations, and physical experiments, scientists can better understand climate variations, surface to atmospheric interactions, and weather phenomena. JPL is developing a research facility, the Planetary Cloud Aerosols Research Facility (PCARF), to conduct physical experiments on the formation, evolution, and other characteristics of aerosols within planetary environments. This facility will provide an advanced understanding of the microphysics, chemistry, and thermodynamics governing aerosol dynamics in the various planetary conditions that occur. This facility will be useful to corroborate and validate data from analytical models, remote sensing or in situ measurement data.

PCARF is comprised of several components designed to simulate and investigate the formation and behavior of planetary aerosols. The facility encompasses a chemical introduction system, serving the dual purpose of introducing both major and minor gas constituents into the chamber and providing Cloud Condensation Nuclei (CCN) to initiate cloud formation processes. The vacuum chamber, capable of generating vacuum conditions to replicate the atmospheric pressures across planetary environments.

A key feature within the facility is the temperature-controlled shroud, equipped with bottom, top and side wall temperature controls. This setup facilitates a temperature gradient, with the top plate colder than the bottom plate creating a Rayleigh-Bérnard turbulent mixing dynamics. Furthermore, the sampling instrumentation includes an Aerosol Mass Spectrometer, Differential Mobility Particle Sizer (DMPS), and Optical Particle Spectrometer (OPS), allowing for precise and comprehensive analysis of aerosol properties within the chamber. In addition, the facility includes a Particle Image Velocimetry (PIV) setup to enable real-time tracking of particles, offering insights into the fluid dynamics within the simulated atmospheric conditions.

8IM.6

Measuring the Charging Efficiency of Unipolar Charger in Electrical Low-Pressure Impactor for Soot Aggregates. NISHAN SAPKOTA, Timothy Sipkens, Mang Guan, Steven Rogak, *University of British Columbia*

The average number of charges on soot aggregates after unipolar charging is much higher than for compact aerosols of the same drag-equivalent diameter. This makes it difficult to interpret measurements from many aerosol instruments, including the Electrical Low Pressure Impactor (ELPI+) which is often used to measure combustion aerosols known to have a fractal-like structure. Previous efforts to determine the charging-equivalent diameter of soot have used soot aggregates classified by a Differential Mobility Analyzer (DMA). However, the presence of multiply charged particles introduces uncertainty, partly because the multiple charged fraction from the classifier is itself influenced by particle morphology. To largely eliminate multiple charging, we classify soot first with an Aerodynamic Aerosol Classifier (AAC) and then a Differential Mobility Analyzer (DMA). Soot was produced from a laminar inverted flame with ethylene or propane as the fuel. Although the soot produced by the two flames had substantially different effective densities, the increased charge on the soot was very similar and for both fuels. The charge carried by the particles is a function of the details of the ELPI+ charger, including penetration and ion current, but the charging of the soot can be universally correlated with the mobility diameter of a sphere (d_m) picking up the same charge i.e. charging-equivalent diameter (d_{qe}). We found the relation to be $d_{qe} = 1.59d_m^{1.12}$, which is expected to be a useful approximation for other instruments using unipolar charging.

8IM.7

Designing a Cloud Chamber and Digital Twin Simulation for Studying Aerosol-Warm Cloud Interactions. KYLE GORKOWSKI, Nevil Franco, Hannah Brink, Liam Wedell, Matthew Nelson, Katherine Benedict, *Los Alamos National Laboratory*

Studying aerosol-cloud interactions in a laboratory setting has traditionally been challenging without access to large-scale facilities. This work introduces an intermediate-scale cloud chamber designed for warm cloud research, within a material cost of $50,000. Utilizing on-demand manufacturing to craft individual components, the chamber is assembled in-lab by a team of two. We detail the design process, encompassing computer-aided design, computational thermal-fluid dynamics simulations, and assembly. Aerosol-cloud processes within the chamber are simulated using Particula, an open-source Python package for aerosol-cloud interactions. By integrating these simulations with measurements, we are developing a digital twin of the chamber, enhancing our capability to replicate and study complex aerosol-cloud dynamics. We will present the chamber design, computational thermal-fluid simulations, initial experimental results, and aerosol-cloud simulations, highlighting our progress in integrating these components into a comprehensive digital twin.

8SC.1

Aerosol InfraRed (AIR) Monitor - Introduction to Continuous Infrared Spectroscopy of Particulate Matter (PM).

NIKUNJ DUDANI, Andrea Baccarini, Arthur Blaser, Satoshi Takahama, *Aerospec SA*

The characterization of aerosol particles, or particulate matter (PM), is essential due to their significant impact on mortality, health and the environment. Infrared (IR) spectroscopy is a non-destructive method, which provides useful chemical information about the constituents (Debus et al., 2022) but is traditionally performed on PM collected on Polytetrafluoroethylene (PTFE) filters for which introduces spectral interferences, limiting detection capabilities. The Aerosol InfraRed (AIR) Monitor, developed at Aerospec, addresses these challenges by enabling continuous FTIR spectroscopy of PM collected on an infrared-transparent substrate and automated spectral processing.

This innovative technology allows continuous measurement of various inorganic chemical groups and organic functional groups (FGs) with enhanced accuracy. The AIR Monitor's design integrates a novel electrostatic precipitation mechanism (Dudani and Takahama, 2020), that ensures high collection efficiency, low size-dependence, and minimal chemical interference, thus providing a more representative sample of the collected polydisperse aerosols, enabling direct quantitative measurements of PM.

In this presentation and demonstration, we will discuss the principles behind the AIR Monitor and its scalability in ambient air quality monitoring. The AIR Monitor's potential to improve our understanding of aerosol composition and its implications for public health will be explored.

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8SC.2

Residue Particles: Tips to Minimize a Potentially Problematic Artifact of Aerosol Generation.

Justin S. Koczak, ANDREA J. TIWARI, Daniel R. Troolin, *TSI Incorporated*

Aerosol generation is a key feature of numerous experimental designs within aerosol research: atmospheric chemistry studies, exposure studies, and other research areas depend on the ability to generate aerosol particles of a desired composition and size distribution. In the case of generating aerosols from a liquid feed material, droplets are created and as the liquid evaporates from each droplet, dry aerosol particles result. This is often a very successful technique when using solutions (e.g., NaCl is dissolved in water, and the solution is aerosolized to create NaCl aerosol). In the case of suspensions such as Polystyrene Latex (PSL), two types of aerosol particles often result: the first is the desired suspended particle while the second is a residue particle, which forms from any typically undesired dissolved nonvolatile species that had been present in the bulk liquid (e.g., surfactants, impurities, stabilizers, etc.). If the residue particles are very different in size compared to the suspended particle size, their presence may not necessarily cause negative effects to the outcome of the experiment. If, however, the suspended particles are comparable in size to the residue, the similarity in size between the two particles types in the aerosol can inhibit accurate characterization of the desired aerosol. This is particularly challenging when examining smaller submicrometer aerosols (e.g., less than 20 nm) in applications such as colloid characterization, liquid purity monitoring, or instrument calibration. This Exhibitor Showcase will illustrate the formation of residue particles using different samples, and will demonstrate how proper selection of an aerosol generation technique can help to reduce the presence and therefore mitigate influence of residue particles.

8UA.1

Lake Breeze Effects on Urban Climate and Air Quality in Chicago Using Microsoft Eclipse Network.

Xiaoyu Chen, Jhao-Hong Chen, Peiyuan Li, Scott Collis, Rao Kotamarthi, Paytsar Muradyan, Ashish Sharma, Lu Xu, JIAN WANG, *Washington University in St. Louis*

Over 100 low-cost air quality sensors were deployed across Chicago from July 2021 to March 2023 and provided high temporal and spatial resolution measurements of Particulate Matter (PM2.5), Ozone (O3), Nitrogen Dioxide (NO2), Carbon Monoxide (CO), relative humidity, and temperature. In this study, we utilize this dataset to investigate the effects of lake breezes on spatiotemporal variations of temperature and air quality in Chicago, which are poorly understood. Machine learning models were employed to calibrate the sensor network data based on reference measurements from EPA or MesoWest stations. Based on meteorological data, we identified 42 lake breezes events in 2022, with 79% occurring in spring and summer. These events typically last between 3 to 8 hours, with the majority of them (61%) starting between 11am and 1pm.We found strong temperature decreases along the lakeshore extending inland, with a maximum reduction of ~3.5℃ during lake breezes events, effectively mitigating heat stress in Chicago during summer. Following lake breeze arrival, ozone mixing ratio declines, potentially due to lower temperatures slowing down photochemical reactions and relatively lower precursor concentrations in the lake breezes. PM2.5 during lake breeze events exhibits varied trends depending on wind speed. High wind speed disperses pollutants and promotes ventilation over the city, resulting in decrease of PM2.5. Conversely, low wind speed leads to the stagnation of pollutants mainly from south of Chicago, increasing PM2.5 levels. The hygroscopic growth of aerosols under higher RH and a shallower boundary layer height during the lake breeze events may also contribute to the increase of PM2.5 concentrations. The lake breeze effects on urban climate and air quality in Chicago are compared to those in other coastal areas. Moreover, initial data and insights from Community Research on Climate and Urban Science (CROCUS) air quality and trace gas measurements are presented.

8UA.2

Elucidating Spatial Variations of Non-Tailpipe Emissions through Comprehensive Saturation and Mobile Measurements across Two Seasons.

CHEOL H. JEONG, Yee Ka Wong, Nicole Trieu, Sophie Roussy, Maria-Teresa Pay-Perez, Xing Wang, Taylor Edwards, Junshi Xu, Milad Saeedi, Arman Ganji, Bruce Urch, Marianne Hatzopoulou, Arthur W. H. Chan, Scott Weichenthal, Greg J. Evans, *SOCAAR, University of Toronto*

Saturation and mobile measurements were employed to explore the spatial variation of tailpipe and non-tailpipe emissions, including resuspended road dust and brake wear particulate matter (PM), across Toronto, Canada. Saturation sampling involved over 80 portable filter samplers deployed at 30~40 sites to collect weekly PM2.5 and PM10 filter-samples across two seasons (October – November 2023, January - March 2024) to determine PM mass, trace elements, and oxidative potential. Ogawa badge sampling was also employed to measure nitrogen oxides (NOx) as an indicator of tailpipe emissions. Mobile sampling over 3500 km and 180 driving hours covered busy urban centres to background parks across the city, focusing on resuspended PM on roadways, as well as ultrafine particles (UFP) and black carbon (BC). To evaluate daily baseline changes and the performance of portable devices in the mobile vehicle, routine stationary sampling at designated sites was included.

An excellent correlation between some trace elements and total PM was observed across the saturation sites. Strong spatial variations in trace elements were noted, particularly with elements such as barium and copper, which are indicative of brake wear. These elements contributed more to PM at sites situated along major roadways. Highly localized increases in resuspended PM were influenced by nearby construction activities, whereas mostly higher UFP and BC, reflective of tailpipe emissions, were found along major roadways. The distinct impacts of brake wear and road dust demonstrated the influence of road types and nearby activities on non-tailpipe emissions. The study underscores the growing contribution of trace metals to PM mass in roadside environments and highlights the importance of understanding the spatial differences in non-tailpipe emissions. Further investigations through the seasonal field campaigns will provide deeper insights into these patterns and help develop strategies for monitoring and mitigating urban non-tailpipe emissions.

8UA.3

Enhancing Polycyclic Aromatic Hydrocarbons (PAHs) Quantification through High-Resolution Aerosol Mass Spectrometry for Mobile Sampling. OLADAYO OLADEJI, Albert Presto, *Carnegie Mellon University*

Polycyclic Aromatic Hydrocarbons (PAHs), a subset of air toxics, pose severe health risks even at low concentrations due to their carcinogenic and reproductive effects. They are semi volatile organic compounds, generated from the incomplete combustion of organic compounds. Despite their significance, spatial distribution studies of PAHs remain limited, largely due to the absence of real-time, chemically specific methods.

This study applies high-resolution aerosol mass spectrometry (AMS) for enhanced quantification and spatial analysis of particle-phase PAHs. Sampling was done in Pittsburgh in which a mobile laboratory was driven over defined routes in areas of varying source activity (e.g., the downtown core, residential areas, and industrial areas).

Laboratory validation utilizing PAH standards and NIST database comparison demonstrated robustness, yielding a 95% correlation coefficient. Moreover, a fragmentation table was devised based on NIST database analysis, enhancing methodological accuracy in identifying PAHs.

Quantification of PAHs, including acenaphthene and acenaphthylene, alongside other PAHs revealed spatial and temporal variability. 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.

Ongoing efforts involve refining the methodology to quantify the Relative Ionization Efficiency of various PAHs, aiming to enhance analytical precision and broaden applicability. This methodological framework advances PAH quantification and offers insights into spatial distribution and emission sources, crucial for air quality management and public health.

8UA.4

Hyperlocal Mobile Monitoring of Particle-Bound Metals in Two Environmental Justice (EJ) Communities in the South Coast Air Basin. Mohammad Sowlat, CHRISTOPHER LIM, Steven Boddeker, Julia Montoya-Aguilera, Zihan Zhu, 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 Los Angeles, Boyle Heights, West Commerce (ELABHWC) and Southeast Los Angeles (SELA) 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, sources of particulate metals near residential areas and sensitive receptors increase 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 a wide range of metals. This presentation focuses on the hyperlocal mobile monitoring component of this campaign, using a multi-metals mobile platform (MMMP) developed as part of the same project, providing granular data on the variation of metals concentrations at the community scale. An overview of the multi-step monitoring strategy employed in this campaign and preliminary results from the surveys conducted will be given. This presentation will also show how the data have been used to learn about potential sources of trace metals, how this work supports further actions to reduce emissions and exposure to ambient particle-bound metals in these communities, and how information obtained in this study has prompted plans to perform full PM speciation at two near-road sites as part of the next Multiple Air Toxics Exposure Study (MATES VI) conducted by South Coast AQMD.

8UA.5

Accessibility to Localized Fine Particulate Matter (PM2.5) Data from Purple Air Sensors in Major U.S. Cities.

MOHAMMED AHMED, Daniel Gingerich, Andrew May, *The Ohio State University*

$PM_{2.5}$ is one of the leading causes of mortality worldwide and if people are aware of their exposure to $PM_{2.5}$, they can take appropriate precautions to reduce risks. The Purple Air (PA) network is by far the most widespread low-cost $PM_{2.5}$ sensor network in the U.S., and hence, has potential to provide localized exposure estimates for nearby residents. We leveraged this network to estimate the spatial accessibility to active PA sensors installed by any user (e.g., non-governmental or personal) at the census-tract level in 32 highly-populated U.S. cities (> 500,000 residents). We found that 14% of the total population of the median city lives within 1-km of a PA sensor, but there is high variability between cities (min.: 1.6%; max.: 97.5%; inter-quartile range: 5.3% – 35.8%). We extended our analysis to consider socio-demographics within 1-km of a PA sensor, including race (Whites or non-Whites), poverty level (above or below the poverty line), age (above or below eighteen), sex (male or female), and housing status (owners or renters). We used a binomial distribution test to compare the population within each buffer to the total population of the city using our defined socio-demographic variables to consider both access and equity to localized sensor data. Based on these tests, we find that across all cities analyzed, residents below the poverty line and renters are as more likely to live within 1-km of a PA sensor, while non-White residents and children tend to be less likely to have this localized access. While this is true in general, there are cities with PA sensor networks that provide more equitable access to localized $PM_{2.5}$ data for non-White residents and children. Nevertheless, additional mechanisms (e.g., policies, funding) are needed to ensure equitable access to localized $PM_{2.5}$ sensor data nationwide.

8UA.6

Using Colocations from 25+ Cities to Create a Global Correction for Optical Low-Cost PM2.5 Sensors.

GARIMA RAHEJA, Daniel Westervelt, *Columbia University*

Air pollution is a leading cause of global premature mortality. Traditional methods of measuring air pollution are expensive, technically challenging, and inaccessible for many low-income marginalized communities. Advancements in low-cost sensors (LCS) are helping bridge the data gap left by these reference-grade monitors. Novel data science techniques are being used to develop correction factors for LCS, but 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 in one community, in another? We use colocations contributed by 25 community projects and regulatory studies (including in NYC, Ohio, Accra, Lomé, Kinshasa, London, and Kolkata) at varying climatologies to assess the performance of 4 machine learning techniques, and compare them to correction factors in the literature. Additionally, we develop a Global Gaussian Mixture Regression (GMR) machine learning model trained on co-locations from communities 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 R2 = 0.88 when compared to the MetOne BAM1020, and in Accra, the GMR lowered Mean Absolute Error of Clarity data from 7.51 ?g/m3 to 1.93 ?g/m3.

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 that using this model could provide high levels of accuracy in a community using LCS without the need for a $100,000+ reference monitor colocation.In some cases, such as Nairobi, the Global Gaussian Mixture Regression model is actually 1.2x better than using correction developed with local colocation.

Global GMR is greater than the sum of its parts: contribution from some communities has reciprocated progress in many more. 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, and has allowed community groups, regulators and policymakers around the world to make the most of their LCS data.

8UA.7

Status Update and Preliminary Results from the Ground-Based Particulate Matter Monitoring Network of the Multi-Angle Imager for Aerosols (MAIA) Investigation. SINA HASHEMINASSAB, David Diner, Jeff Blair, Ann M. Dillner, Yang Liu, Christian L'Orange, Randall Martin, Christopher Oxford, Jeremy A. Sarnat, MAIA Team, *Jet Propulsion Laboratory, Caltech*

NASA and the Italian Space Agency (ASI) are jointly implementing the Multi-Angle Imager for Aerosols (MAIA) investigation to explore the association between PM types and adverse health outcomes. The MAIA satellite instrument—a multi-angle imaging spectropolarimeter set for launch in 2025—will collect measurements of column-integrated aerosol optical and microphysical properties over selected Primary Target Areas (PTAs) in North America, South America, Europe, the Middle East, Africa, and Asia. These measurements will be integrated with data from ground-based PM monitors and outputs of the WRF-Chem atmospheric model to generate daily maps of near-surface total PM_{10}, total $PM_{2.5}$, and speciated (sulfate, nitrate, organic carbon, elemental carbon, and dust) $PM_{2.5}$ mass concentrations at 1 km spatial resolution.

This presentation will provide a status update on MAIA's ground-based PM monitoring network and share preliminary findings. MAIA leverages existing ground-based PM monitoring networks where available and expands upon them with additional equipment in several PTAs. The project capitalizes on the existing SPARTAN Surface Particulate Matter Network for $PM_{2.5}$ speciation and has expanded this network with additional filter samplers; deployed Colorado State University filter samplers to complement $PM_{2.5}$ speciation networks; and installed AethLabs microAeth MA350 monitors for black carbon measurements. In Ethiopia, where few $PM_{2.5}$ monitors have historically been operating, a set of calibrated PurpleAir sensors has been deployed to enhance the spatial coverage of ground-based $PM_{2.5}$ measurements.

Preliminary results show elevated PM concentrations at PTAs in low- and middle-income countries (LMICs), particularly New Delhi, India, where annual average $PM_{2.5}$ levels approach 100 µg/m³, three to eleven times higher than levels measured in the other PTAs. The chemical composition of $PM_{2.5}$ also varies substantially across PTAs, with black carbon—a tracer for diesel and biomass burning—found at levels up to twelve times higher in LMICs (e.g., India and Ethiopia) compared to high-income countries.

9AC.1

Multiphase Reactivity of Benzotriazole Ultraviolet Stabilizers.

YAO YAN HUANG, Jonathan Abbatt, *University of Toronto*

Benzotriazole ultraviolet stabilizers (BUVs) are a class of chemicals used to prevent the degradation of materials from ultraviolet (UV) radiation that are added to various consumer and industrial products such as paints, polymers and food packaging, and textiles. They are highly recalcitrant with a growing concern as an environmental contaminant, observed in water bodies, sediment, and in airborne dust and aerosols. Their reactivity and degradation pathways in the environment are still largely unknown. Their presence in airborne dust, aerosols, and consumer products suggests a potential exposure and transformation potential in everyday environments that many other additives are also privy to. In a series of laboratory experiments, the multiphase reactivity of two BUVs (UV-328, UV-P) with gas phase oxidants ($\cdot OH$, O_3, and $\cdot NO_3$) and UV-C radiation was investigated. All experiments were carried out in an oxidation flow reactor for up to 24h at different mixing ratios. The reaction was monitored off-line by liquid chromatography tandem mass spectrometry (LC-MS/MS). BUVs were deposited at 2.5 nm and 0.5 nm thick layers and dissolved in less-reactive thin films of dioctyl sebacate. Both pure UV-328 and UV-P were found to be recalcitrant to heterogenous O_3 oxidation up to 1000 ppb in 24h. Additional experimental results in other reaction conditions will be reported, as well as an analysis of reactivity within a common consumer product such as plastic. The reaction products, if any, will be investigated and identified using liquid chromatography high resolution mass spectrometry (LC-HRMS) and a reaction pathway will be proposed. This work aims to provide information about the environmental fate of BUVs and their reactivity in complex environments.

9AC.2

The Potential for Chlorine Activation in Continental Environments and from Urban Grime Surfaces.

EMMA MCLAY, Yao Yan Huang, D. James Donaldson, Trevor VandenBoer, *York University*

Atmospheric chlorine radicals can play a role in atmospheric oxidation pathways that may lead to ozone and secondary organic aerosol (SOA) production. Their importance derives from their reaction rates which exceed those of hydroxyl radicals by 1-2 orders of magnitude. Nitryl chloride ($ClNO_2$), a well-known precursor to chlorine radicals, is largely understood to come from heterogeneous reaction of chloride-containing surfaces with N_2O_5, but these are predominantly limited to aerosols with sea-salt influence, despite the observed presence of $ClNO_2$ in continental areas free of sea-salt aerosol. This work aims to understand heterogeneous $ClNO_2$ chemistry in continental areas and on non-aerosol surfaces, like urban grime, the chemically complex films found on impervious urban surfaces.

Analysis of publicly available particulate matter ionic composition data from Canadian continental locations (Etobicoke, Saskatoon, Quebec, and Montreal) revealed ubiquitous depletion of chloride with correlation of nitrate and the sodium-chloride difference ('missing chloride'). This implies displacement of chloride by nitrate through some mechanism, which is enhanced during wintertime when road salts are applied. Similarly, in a study of urban grime samples from three continental locations in Ontario, evidence for such displacement was also found, but only for one location (Toronto) and with reversed seasonality. This prior work inspired a concerted field campaign in February 2024 in Toronto where urban grime and size-resolved aerosol samples were collected simultaneously, targeting road salt influence, in addition to summertime collection of size-resolved aerosols for comparison. Ionic composition of both sample types will be determined and compared. Direct reaction of N_2O_5 with the urban grime samples in a coated-wall flow tube reactor will be conducted to probe any $ClNO_2$ production. This presentation will explore Cl-reservoirs and $ClNO_2$ production from aerosol and non-aerosol surfaces in environments that are currently lacking study, providing additional insight into broader chlorine chemistry that can contribute to atmospheric oxidation.

9AC.3

Influence of Relative Humidity and Irradiation on the Reactive Uptake of Ozone onto Secondary Brown Carbon from Catechol in Thin Films.

SITHUMI LIYANAGE, Habeeb Al-Mashala, Katrina Betz, Elijah Schnitzler, *Oklahoma State University*

Light-absorbing organic aerosol, or brown carbon (BrC), influences climate directly by absorbing and scattering radiation and indirectly by affecting cloud formation and properties. Whether the combination of these effects exerts a warming or cooling effect on Earth's radiative balance depends on the evolution of the optical properties of BrC induced by multiphase processing by atmospheric oxidants, including ozone, which is governed by the viscosity of the aerosol particles. There is evidence that the viscosity of secondary BrC from phenolic precursors, abundant emissions of biomass burning, is higher than that of primary organic aerosol from biomass burning. Here, we investigate the reactivity of secondary BrC from catechol, in terms of the loss of ozone from the gas-phase over thin films in a coated-wall flow tube. Secondary BrC was generated from the aqueous OH-initiated oxidation of catechol under ultraviolet (UV) irradiation in a photo-reactor. Thin films were prepared from reconstituted, concentrated solutions in ethanol following rotary evaporation of the aqueous reaction mixtures. The effects of relative humidity (RH) and UV irradiation of the thin films were determined. At 0% RH, the uptake coefficient at 4 h of ozone exposure (initially 130 ppm) was less than previously observed for primary BrC from biomass burning, consistent with higher viscosity. The uptake coefficient was even less after UV irradiation. At intermediate RH, the reactive uptake increased significantly, consistent with plasticization of the secondary BrC components, which are still completely water-soluble at the end of the aqueous photo-oxidation experiments. At 75% RH, the thin film deliquesced and coalesced into large droplets, precluding reactive uptake measurements. The implications of these results on the evolution of BrC will be discussed.

9AC.4

Laboratory Characterization of the Aqueous-Phase Oxidation of Dimethyl Sulfide (DMS) and Its Oxidation Products.

SEAMUS FREY, Lexy LeMar, Jesse Kroll, *MIT*

The oxidation of dimethyl sulfide (DMS) and its products represents a major natural source of sulfate aerosols in the atmosphere. This multi-generational oxidation therefore has major implications for the global sulfate budget both in the pre-industrial times, the present day, and in future atmospheres. While such oxidation processes may occur in both the gas and aqueous phases, previous studies have primarily explored DMS oxidation in the gas phase only, with far fewer studies focusing on aqueous-phase DMS oxidation. As a result, the product distributions, mechanism, and impact of DMS oxidation in the atmospheric aqueous phase (i.e., deliquesced aerosol particles and cloud droplets) remain highly uncertain. Here, we address this uncertainty via laboratory studies of the aqueous-phase oxidation of DMS and its various oxidation products. Organosulfur species (DMS, dimethyl sulfoxide, methylsulfinic acid, and methylsulfonic acid) were oxidized in a new bulk-aqueous-phase reactor, and their products were analyzed in near-real time using electrospray ionization-Orbitrap mass spectrometry (ESI-Orbitrap-MS). Product distributions from oxidation of these sulfur-containing compounds in the aqueous phase were compared to those of the gas phase, enabling identification of differences in branching ratios and in mechanisms across phases. Results from this study enable the development of an improved DMS oxidation mechanism, which in turn can be used for improved predictions of sulfate aerosol in 3D (chemical transport and Earth system) models.

9AC.5

Characterization of Acid-Base Aerosol Nanoclusters Using a Thermal Desorption Chemical Ionization Mass Spectrometer with a Half-Mini Differential Mobility Analyzer. COLLEEN MILLER, Paulus Bauer, Patricia M. Morris, Véronique Perraud, Barbara Finlayson-Pitts, James Smith, *University of California, Irvine*

New particle formation (NPF) events are a significant source of ambient aerosols, but uncertainty exists in the understanding of how newly formed clusters grow from ~1 nm to 10 nm in diameter, which we refer to here as the aerosol nanocluster (AN) size range. The growth process is thought to be dependent on the chemical composition of the AN, with acid-base ratios, oxidation state, and other physicochemical properties influencing their development. A gap currently exists in our ability to measure AN composition, with current instruments capable of measuring gas-phase clusters up to about 2 nm and aerosol online instruments capable of chemically characterizing nanoparticles greater than 10 nm. This is a challenging size range to measure due to their small sizes and mass as well as the short lifetimes associated with these particles.

Here, we used a Thermal Desorption Chemical Ionization Mass Spectrometer to measure the composition of ANs size-selected using a Half-Mini Differential Mobility Analyzer (SEADM S.L.). ANs were generated using a bipolar electrospray, which enabled the formation of mostly singly charged clusters. For initial proof of concept, tetraheptylammonium bromide particles were first investigated followed by atmospherically relevant acid-base salt ANs such as those comprised of 4-aminobutaol and methanesulfonic acid. Results from bipolar electrospray generated ANs are compared with ANs generated from acid-base reactions in a flow reactor. Through these studies, we directly observe the chemistry of particle growth in its earliest stage, thereby contributing substantially to our understanding of atmospheric NPF events.

9AC.6

Use of an Oxidation Flow Reactor to Study Secondary Aerosol Formation from Methylated Selenium Compounds. YING ZHOU, Linhui Tian, Erin Bowey, Michael Lum, Ying-Hsuan Lin, Roya Bahreini, Don Collins, *University of California, Riverside*

Selenium (Se) is an essential dietary trace element impacting human health. It is emitted into the atmosphere from a variety of natural and anthropogenic sources. Some volatile methylated selenium compounds, such as dimethyl selenide (DMSe) and dimethyl diselenide (DMDSe), exist widely in the atmosphere. However, their potential to form secondary aerosol and their role in the atmospheric cycling of Se are still poorly understood. Here we describe the results from the use of an oxidation flow reactor (OFR) to study secondary aerosol formation from DMSe and DMDSe when dry seed aerosols, aqueous seed aerosols, or droplets were present in the reactor. The gas composition of the flow exiting the OFR was measured by a High-Resolution Time-of-Flight Chemical Ionization Mass Spectrometer (HR-ToF-CIMS), while the size distribution and composition of the exiting particles were measured by a Scanning Mobility Particle Sizer (SMPS) and a mini-Aerosol Mass Spectrometer (mAMS), respectively. For OFR operation resulting in an equivalent photochemical age of 7-8 days, the formation of secondary aerosol from DMSe, was 25% higher when aqueous seed particles were present in the reactor than when dry seed particles were, but was 57% lower when ~3.5 micrometer cloud droplets were present. Secondary aerosol formation from DMDSe for a photochemical age of 8-9 days was 35% and 7% higher when aqueous seed particles and cloud droplets were present, respectively, compared to that with dry seed particles. Additionally, we identified various gas-phase oxidation products initiated by OH radicals, including selenium dioxide (SeO_2), selenious acid (H_2SeO_3), and selenic acid (H_2SeO_4). These results provide evidence of the varied secondary aerosol formation potential of DMSe and DMDSe from gas- and aqueous-phase oxidation and reveal several gas-phase oxidation products that will be helpful for future studies aimed at understanding the dominant oxidation mechanisms.

9AC.7

Composition and Volatility Comparisons for Limonene Secondary Aerosol Generated from Multiple Oxidants. MANJULA CANAGARATNA, Mitchell Alton, Harald Stark, Anita Avery, Andrew Lambe, *Aerodyne Research, Inc.*

Limonene is a monoterpene that is emitted from natural and anthropogenic citrus sources, with significant OVOC/SOA formation potential in indoor and outdoor environments due to its high reactivity towards gas-phase oxidants. Here, we report laboratory measurements of low-volatility gas and condensed-phase compounds obtained from the oxidation of limonene by a variety of oxidants including ozone, hydroxyl radicals, nitrate radicals, chlorine atoms, and bromine atoms. Limonene was continuously input to a novel Potential Aerosol Mass Dual Oxidation Flow Reactor configured to generate two different oxidants in separate OFRs at the same time. To maximize measurement throughput, instruments alternated sampling between the two OFRs. A fast-switching bipolar time-of-flight chemical ionization mass spectrometer (CIMS) was also utilized to detect gas and particle products. This CIMS cycled through iodide (I-), benzene (C6H6+), and acetone dimer ((C3H6O)2H+) reagent ions at a 2 second data acquisition rate per cycle, enabling the detection of a broader range of organic species than can be detected with a single reagent ion. The gas and condensed-phase oxidation products resulting from the various oxidation regimes are compared. Results from positive matrix analyses of the combined multi-reagent ion datasets are discussed and evaluated. Chemically speciated aerosol volatility measurements obtained while coupling this multi-reagent ion instrument to a FIGAERO inlet (Filter Inlet for Gases and Aerosols) are also presented.

9AC.8

Thermostability of Condensed-phase Amines in the Presence of Sulfuric and Oxalic Acids. Grace Teall, CHONG QIU, *University of New Haven*

Reduced Nitrogen Compounds such as ammonia and amines are widely observed in the ambient particulate matters and may neutralize inorganic and organic acids in the particle phase to increase the aerosol pH. The physical and chemical properties of the resulting salts, especially those associated with amines, remain largely unknown, creating barriers on better understanding the formation and transformation of ambient aerosol, especially in marine, agricultural and some industrial environments with significant amine emissions. Previous studies presented complex behaviors of particle-phase amine salts under various conditions, casting doubts on the true chemical identities and compositions of aerosol samples containing amines.

In this study, a molecular-level, bottom-up approach was used to investigate the thermostability of the salts of selected alkylamines (methylamine, MA; dimethylamine, DMA; and trimethylamine, TMA) with sulfuric and oxalic acids (as representative inorganic and organic diacids in ambient particles, respectively). The sulfate and oxalate salts of the three amines have been chemically synthesized, and their chemical identities verified. Thermal Gravimetric Analyzer (TGA) was used to determine the thermal decomposition profile of milligram scale salt samples in their dry state and in aqueous solutions. Considering the curvature effect, the results on amine sulfates appeared to agree well with those from aerosol-based measurements. Oxalate salts of the three amines demonstrated significantly lower decomposition temperatures than those of the respective sulfate salts. The stability of sulfate and oxalate salts of these amines depends strongly on their chemical structures and phase state. For example, MA and DMA oxalate salts are thermally stable both in dry state and in aqueous solution; but it was not possible to isolate TMA oxalate from its aqueous solution due to its thermal instability and subsequent decomposition into TMA hydrogen oxalate. Our results suggested that the diacid salts of DMA will consistently decompose at higher temperatures than those of MA and TMA salts, yet the presence of condensed water may affect its %mass remaining after thermal heating. Our lab measurements may help explain some of the field observations and provide fundamental property data for further modeling, computation and simulation.

9AC.9

Estimating the Formation of Secondary Organic Aerosol under Controlled Atmospheric Conditions. YANYU ZHANG, David R. Cocker III, *University of California, Riverside*

Secondary Organic Aerosol (SOA) plays an essential role in air quality, climate, and human health. Oxidation of both anthropogenic and biogenic sources of Volatile Organic Compounds (VOCs) contribute to SOA formation. Traditional chamber experiments provide limited insight as they typically estimate SOA formation from a single precursor whose reactive chemistry (e.g., OH/HO_2, NO/NO_2, O_3, etc.) is controlled by the oxidation processes of the single precursor itself. However, the real atmosphere consists of not just the single SOA precursors but also a complex mixture of organic compounds that control the reactive chemistry, making accurate prediction of SOA formation from a single precursor experiment difficult. In this study, environmental chamber experiments were conducted in the 120 m^3 environmental chamber at University of California Riverside Atmospheric Processes Laboratory (APL). Surrogates (defined mixtures of Reactive Organic Gases (ROGs)) were added to a series of single precursor environmental chamber simulations to fix atmospheric reactivity and further our understanding of SOA formation from selected precursors, like α-pinene, m-xylene, etc. Two groups of surrogate mixture of ROGs were selected to represent the reactivity of an anthropogenic urban atmosphere (e.g., Los Angeles) and a strong biogenic-influenced urban atmosphere (e.g., Atlanta). With the surrogates introduced, the pathway of the gas mechanism is controlled by the oxidation chemistry, primarily associated with the surrogate mixture and with little influence from the test compound itself. The experiments demonstrate that the concentration of gas phase species is heavily affected by the surrogates instead of the added precursor, whereas the aerosol physical and chemical properties are heavily affected by the added precursor. Our work enables the development of incremental aerosol formation scales for anthropogenic and biogenic surrogate systems, and improve our understanding of different factors that contribute to SOA formation.

9AC.10

Biomass Burning Organic Aerosol as a Pool of Reactive Triplet Molecules to Drive Multiphase Reactions. ZHANCONG LIANG, Liyuan Zhou, Yuqing Chang, Salim Sioud, Chak K. Chan, *King Abdullah University of Science and Technology*

Massive biomass-burning organic aerosols (BBOA) have been emitted to the atmosphere due to intensified wildfire events in recent years. While the light-absorbing properties and lifetime of BBOA, as well as their impacts on radiative balance, have been extensively explored, the multiphase photochemistry of BBOA is less studied. In this study, we demonstrated the remarkable photochemical reactivity of BBOA, evidenced by the efficient oxidation of SO_2 to sulfate under light exposure and N_2 conditions. Triplet states were identified as the primary drivers of sulfate formation, with triplet concentrations in BBOA exceeding those found in ambient particle extracts due to the abundance of photosensitizers in BBOA. Additionally, the photosensitized sulfate formation rate in BBOA was 4 orders of magnitude higher than the modeled value based on kinetic parameters for bulk solutions, likely due to accelerated photosensitized reactions at the interfacial layers of BBOA. Moreover, the photosensitized sulfate formation rate was doubled in air over that in N_2, highlighting the critical role of oxygen. Control experiments suggest that the reactive singlet oxygen ($^1O_2$) is likely the main contributor to the enhanced sulfate formation in air. This study highlights the significant role of BBOA in triggering multiphase photochemical reactions that generate secondary pollutants, in addition to their direct contributions to global warming through light absorption.

9AC.11

Particle-Phase Formation of OOMs in Biogenic New Particles: New Insights from LC-ESI Orbitrap and FIGAERO-CIMS Mass Spectrometer Analysis. VIGNESH VASUDEVAN GEETHA, Lee Tiszenkel, Robin Russo, Daniel J. Bryant, Shanhu Lee, *The University of Alabama in Huntsville*

Formation of low-volatility oxygenated organic molecules (OOMs) from volatile organic compounds (VOCs) such as monoterpenes is a major topic of interest in atmospheric chemistry. OOMs are key ingredients for the formation and growth of new particles and the formation of secondary organic aerosol (SOA) particles. It is generally believed that OOMs form in the gas phase via autoxidation reactions and then undergo gas-to-particle conversion; for example, this is the mainstream mechanism of new particle formation (NPF) currently. Recent studies have also shown possible pathways for OOMs formation within SOA particles; however, it is not clear how particle-phase reactions contribute to the formation of OOMs in newly formed particles. We conducted laboratory experiments of NPF using alpha-pinene ozonolysis reactions in a fast flow reactor, and analyzed the chemical composition of OOMs in the gas phase as well as in the nearly formed particles (up to approximately 50 nm) using the filter inlet for gas and aerosol attached to chemical ionization mass spectrometer (FIGAERO-CIMS) and the offline liquid chromatography (LC)-Orbitrap mass spectrometers. The combination of these two independent high-resolution mass spectrometer techniques enables us to gain new insights into the particle-phase OOMs compositions at different time scales based on the detailed isomer-resolved molecular structures and volatility analysis. The LC-Orbitrap MS/MS mass spectrometer analysis shows the presence of isomeric compounds with distinctively different structural moieties, which can be attributed to different formation pathways, such as gas-to-particle conversion, particle-phase, and heterogeneous reactions. This presentation will discuss particle-phase formation of OOMs – a previously unidentified yet potentially significant process – in newly formed particles

9AC.12

Particulate Nitrate Photolysis in HONO Production: Impacts of Aerosol Phase States, Acidity, and Actinometry Calibration. JUN ZHENG, He-shan Ning, Yan Ma, *Nanjing University of Information Science and Technology*

Productions of nitrous acid (HONO) from the photolysis of ambient particulate nitrate (PN) samples were investigated using a solar irradiation simulator. The measured apparent HONO production rate ($J_{PN\text{-}HONO}$) ranged from 4.4×10^{-6} s^{-1} to 8.3×10^{-5} s^{-1}, with an average of $(2.5\pm1.7)\times10^{-5}$ s^{-1}. Release of nitrogen dioxide (NO_2) was simultaneously detected with HONO with a production rate ($J_{PN\text{-}NO2}$) ranging from 3.2×10^{-6} s^{-1} to 7.9×10^{-5} s^{-1} and an average of $(2.3\pm1.6)\times10^{-5}s^{-1}$. $J_{PN\text{-}HONO}$ and $J_{PN\text{-}NO2}$ appeared to vary with the time of sample collection, showing a distinctive daily maximum around early morning and a minimum around noontime. It was found that irradiated particle filter samples ceased to release HONO, while ~90% PN was estimated to remain on the filter. Moreover, the sum of HONO and NO_2 produced during the experiment only accounted for about ~2% of the consumed PN. These observations indicated that HONO and NO_2 formation from PN photolysis can only occur within a thin layer of PN-containing shell. Limited aerosol liquid water content (ALWC) may prevent most PN from dissolving into the aqueous phase. It was also found that the irradiation intensity within the solar simulator was underestimated by the traditional aqueous-nitrate actinometry due to the solvent cage effects within the bulk nitrate solution, leading to the recombination of free radicals generated by the irradiation. Interestingly, the effects of overestimated reactive PN contents and underestimated irradiation intensities may cancel each other somewhat, leading to similar values of $J_{PN\text{-}HONO}$ and $J_{PN\text{-}NO2}$ reported in previous studies.

9AC.13

Probing Reaction Pathways of Organic Radicals in the Atmospheric Aqueous Phase. LEXY LEMAR, Victoria Barber, Seamus Frey, Yaowei Li, Frank Keutsch, Jesse Kroll, *MIT*

The oxidation reactions that lead to the formation of secondary organic aerosol (SOA) can occur in both the gas phase and the condensed phase. Critical to these processes are the chemistry of key organic radical intermediates (R, RO, and RO_2); while the reactions of these species in the gas phase have seen substantial study, their reactions in the atmospheric aqueous phase (i.e., cloud droplets, deliquesced aerosol particles) have not. The presence of liquid water could affect this chemistry, and ultimately product distributions, due to locally high concentrations, solvent effects, and competition with reactions unique to the aqueous phase, such as oligomerization or hydrolysis. In this study, we investigate how the reaction pathways of alkoxy (RO) and peroxy (RO_2) radicals differ between the gas and aqueous phases through the use of an environmental chamber and bulk aqueous reactor. A suite of real-time analytical instruments (an aerosol mass spectrometer, a chemical ionization mass spectrometer, and a scanning mobility particle sizer) is used to measure both gas- and aerosol-phase products, yielding insight into reaction mechanisms and branching ratios. Direct comparison of the evolution of various products across phases provides new insight into how phase affects radical reactivity, enabling the improved understanding of SOA and other species formed from aqueous-phase oxidation.

9AC.14

Emission Verification for Ozone Precursors. TRINITY OLGUIN, Gabrielle Cano, Pierre Herckes, Matthew Fraser, *Arizona State University*

Tropospheric ozone is formed from atmospheric precursors such as NO_X and volatile organic compounds (VOCs). In addition to being ozone precursors, VOCs contribute to secondary organic aerosol (SOA) formation which contributes to worsened air quality. In the Phoenix metropolitan area, which is partially in violation of the federal quality standards for ozone, VOC emissions are monitored and estimated by the Maricopa County Air Quality Department (MCAQD). In the four most recent Periodic Emissions Inventories (PEIs), it was estimated that biogenic VOC emissions exceeded anthropogenic VOC emissions. It was also estimated that these biogenic VOC emissions increased by approximately 2.4 times from 2011 to 2014, and then decreased by 2.2 times from 2017 to 2020. These changes may have been caused by updates to the model, the Model of Emissions of Gases and Aerosols in Nature (MEGAN), as well as the model’s inability to accurately estimate BVOC emissions in this southwestern desert region. The MEGAN model is more commonly informed by areas with nature profiles that are significantly different than the Sonoran Desert. Due to these large observed changes in modeled estimates, it is necessary to verify the BVOC emissions to ensure that government agencies take the most effective steps toward decreasing tropospheric ozone and SOA formation. These verifications are done using the eddy covariance technique, which correlates fast gas concentration measurements with wind measurements to calculate BVOC fluxes at an ecosystem scale. The use of a proton transfer reaction time-of-flight mass spectrometer coupled with a gas chromatograph (PTR-TOF-MS/GC) allowed for the characterization and quantification of BVOC emissions throughout different seasons. Here we present the preliminary results of the spring and summer field studies investigating BVOC fluxes in Maricopa County, Arizona.

9AC.15

Evolution of Atmospheric Brown Carbon in Wildfire Smoke Plumes during the 2019 FIREX-AQ and 2023 AEROMMA Field Campaigns.

JHAO-HONG CHEN, Umamaheshwara Rao Puttu, Robert J. Yokelson, Vanessa Selimovic, Nicholas Wagner, Joshua P. Schwarz, Han N. Huynh, Adam Ahern, Ming Lyu, Lu Xu, *Washington University in St. Louis*

Atmospheric brown carbon (BrC) is the light-absorbing fraction of organic aerosol (OA), a major component of particulate matter (PM) emitted from wildfires and plays an important role in climate models to account for global radiative forcing. The evolution of BrC is still not well understood due to several factors, including the variation of wildfire emissions from various fuel types and variable combustion conditions, and the limitation of the assumption of the pseudo-Lagrangian sampling from aircraft measurements. To account for the impacts of fuel types, we group the fuel types into several clusters according to their similarities. We find that BrC from different fuel types behaves differently, which partly explains the observed variability of BrC evolution in the field. Further, to mitigate the fluctuations from emission sources, we normalize the measured BrC in the field by the estimated BrC emission ratio based on the 2016 FIREX FireLab study. This method can largely explain the variability of measured BrC during the 2019 FIREX-AQ and 2023 AEROMMA field campaigns. Overall, this study helps constrain the climate model to account for the global radiative forcing by providing a comprehensive information of evolution and lifetime of BrC from wildfires.

9AC.16

Molecularly Resolved Composition of Ultra-Fine Particles in Aircraft Engine Exhaust Suggests Rapid Condensation of Lubrication Oil.

ZACHARY DECKER, Peter A. Alpert, Markus Ammann, Julien Anet, Michael Bauer, Tianqu Cui, Lukas Durdina, Jacinta Edebeli, Martin Gysel, André S. H. Prévôt, Lu Qi, Jay G. Slowik, Curdin Spirig, Sarah Tinorua, Florian Ungeheuer, Alexander Vogel, Jun Zhang, Benjamin Brem, *Laboratory of Atmospheric Chemistry, Paul Scherrer Institute*

Aircraft emit a large number of Ultra Fine Particles (UFPs, particles <100 nm) which degrade air quality. UFPs efficiently transport their chemical content into the body and it is known that UFPs near airports contain aircraft lubrication oil. However, knowledge of the relationship between aircraft operation and emission of oil-containing UFPs is poorly understood. Results here provide molecularly resolved composition of oil-containing UFPs from six in-service aircraft engines. The detection of 36 unique oil tracers confirms oil emissions from all engines. The UFP oil composition is thrust, particle size, and tracer volatility dependent. Lower volatility tracers are disproportionately present on particles < 30 nm. Particles <10 nm have the greatest oil mass to particle volume ratio. Both engine oil consumption and UFP oil content increase with engine thrust. Thrust-dependent UFP oil composition depends on tracer volatility suggesting rapid gas-to-particle partitioning and that a significant fraction of oil remains in the gas phase at least 50 meters behind the engine. The thrust-dependent oil consumption rate (~0.1 – 0.8 kg/hr) would, at most, represent an oil emission index at cruise altitude of 10 mg/kg similar to that of black carbon. For any flight >2 h the majority of oil emission will occur at cruise altitude highlighting the unknown importance of oil emission in the upper atmosphere.

9AC.17

The Impact of Structure on Alkane SOA Formation. AZAD MADHU, Myoseon Jang, Yujin Jo, *University of Florida*

Alkanes represent significant proportions of hydrocarbon emissions in urban environments. Alkanes emissions are primarily anthropogenic, released from sources such as fossil fuels, pesticides, and various volatile chemical products. Previous literature has demonstrated that the inclusion of intermediate volatility organic compounds, such as alkanes, can significantly improve predictions of regional organic aerosol formation. In this work, parameters are developed for the simulation of secondary organic aerosol (SOA) formation from linear, branched, and cyclic alkanes using the UNIPAR model. The UNIPAR model simulates SOA formation, for a given hydrocarbon precursor, via multiphase partitioning and considers heterogeneous particle-phase reactions. To do so, UNIPAR relies on a product distribution representing each SOA precursor HC, created by lumping the products from a semi-explicit gas oxidation mechanism into an array based on their volatility and reactivity. The addition of autoxidation reactions to the MCM mechanisms of linear alkanes C9-C12 is demonstrated to significantly improve SOA predictions. To simulate SOA formation from larger linear alkanes without MCM mechanisms available, an incremental volatility coefficient is used to unify and extrapolate existing product distributions. Additionally, branched alkane product distributions are represented with the product distribution of the linear alkane with the nearest vapor pressure. To account for the impact of methyl branches on autoxidation, the representative linear alkane product distribution is augmented by an autoxidation reduction factor which is a function of the degree and position of branching. Due to the unique oxidation products of cyclic alkanes, cyclohexane and decalin gas oxidation mechanisms are used to create their respective product distributions. The product distribution of cyclohexane and decalin are then extended to cyclic-branched species which feature cyclic structures with attached branches of varying lengths. Parameters developed for linear, branched, and cyclic species are validated against data collected from the UF-APHOR outdoor photochemical smog chamber.

9AC.18

Impact of Sulfur-Containing Groups on Aqueous-Phase OH Radical Oxidation – Atmospheric Implications for Small Organosulfur Compounds. DONGER LAI, Thomas Schaefer, Yimu Zhang, Yong Jie Li, Sinan Xing, Hartmut Herrmann, Man Nin Chan, *The Chinese University of Hong Kong*

Organosulfur compounds are known to be important components of atmospheric aerosols and cloud droplets, which have major implications on human health, environment, and climate. The presence of hydrophilic moiety within their molecular structures contributes to their low volatility and significant relevance in atmospheric aqueous-phase chemistry. To date, while their formation mechanisms have become better understood, the transformation pathways, particularly concerning aqueous-phase OH radical oxidation, have remained largely unexplored. In this study, we used laser flash photolysis-long path absorption setup together with competition kinetics methods to investigate the reaction rate constants and temperature effects on aqueous-phase OH radical oxidation of five small organosulfur compounds. Moreover, we also examined the importance of considering the sulfur-containing functional groups (sulfate and sulfite functional groups) on the kinetics by extending the structure-activity relationship (SAR) model to organosulfur compounds. The measured rate constants, ranging from 10^6 to 10^8 L mol^{-1} s^{-1}, and showed a positive temperature dependence across temperature range of 278 to 318 K. Our results also revealed that two sulfur-containing functional groups exhibit a strong deactivating effect on the two adjacent carbon atoms. Specifically, the sulfate group displayed a F value (α-neighboring effect) of 0.22, while the sulfite group exhibited an F value of 0.05. Furthermore, the G parameters (β-neighboring effect) were determined to be 0.44 for the sulfate group and 0.32 for the sulfite group. These values infer that the presence of two sulfur-containing functional groups will lower the hydrogen abstraction rates upon OH radical oxidation and this behavior could be explained by their strong electron-withdrawing natures. Overall, the experimentally determined rate constants obtained bridge a crucial gap in model assessments, and the observed deactivating effect of sulfur-containing functional groups enhance our understanding and predictive capabilities regarding the lifetimes of other organosulfur compounds in the atmosphere.

9AC.19

Gas-Particle Partitioning of Volatile Methyl Siloxane Oxidation Products in the New York City Airshed. JOSIE WELKER, Jeewani Meepage, Saeideh Mohammadi, Christopher Brunet, Hanalei Lewine, Rachel Marek, Keri Hornbuckle, Eleanor Browne, Charles Stanier, Elizabeth Stone, *University of Iowa*

Decamethylcyclopentasiloxane (D_5) is commonly used in personal care products and is highly volatile. In the atmosphere, D_5 is oxidized primarily by OH radicals to form 1-hydroxynonamethylcyclopentasiloxane (D_4TOH). D_5 oxidation products can partition to the particle phase to form secondary organic aerosol (SOA). While the gas-particle partitioning of D_4TOH has been studied in the laboratory with model aerosols, it has yet to be established in ambient air. To fill this gap, this study examines the gas and particle distribution of D_4TOH in ambient air in Manhattan, New York City during the summer of 2022. Solvent extraction and gas chromatography mass spectrometry methods were used to analyze gas and particle samples for D_4TOH and polycyclic aromatic hydrocarbons (PAHs). The fine particle fraction of PAHs increases as the molecular weight and number of carbons in the compound increase. The average fractions of PAH in the particle phase measured in New York City (n=13) were ~ 0% for 10-14 carbons (two-three rings: naphthalene, acenaphthene, and phenanthrene), 3% for 16 carbons (four rings: pyrene), 21% for 18 carbons (four rings: benzo(ghi)fluoranthene), 94% for 20 carbons (five rings: benzo(e)pyrene), and 100% for 22 carbons (five rings: picene). The fine particle fraction of D_4TOH ranged from 23% to 69% (for n=13, $\bar{x}$: 52%, σ: 0.13), with the remainder in the gas phase. Using the absorptive partitioning model, D_4TOH is predicted to have an average fine particle fraction of < 1%. These results show that D_4TOH partitions to the particle phase at a higher fraction than would be predicted by absorptive partitioning, suggesting that particle composition and/or adsorption substantially increase its partitioning to the particle phase.

9AC.20

Modeling SOA Formation from Phenols Using an Updated Gas-Phase Mechanism and Revised SOA Parameters. JIA JIANG, Samiha Binte Shahid, Yanyu Zhang, David R. Cocker III, William P. L. Carter, Kelley Barsanti, *University of California, Riverside*

The increasing frequency and intensity of wildfires, driven by climate change and human activities, have significant implications for tropospheric chemistry and air quality due to the emission of volatile organic compounds (VOCs). Among these VOCs, phenolic compounds (phenols) are key constituents of wildfire emissions and play a crucial role in atmospheric reactions. Accurate representation of the chemistry of phenols is critical for modeling secondary organic aerosol (SOA) formation when these compounds contribute significantly to emissions. In this study, we present an updated detailed mechanism for phenolic compounds under atmospheric conditions. The reaction schemes integrate existing experimental and theoretical data with estimations derived using the SAPRC Mechanism Generation System (MechGen). This new mechanism was evaluated against data from environmental chamber experiments using the F0AM box modeling framework, with an SOA model based on AERO in CMAQ. The volatility basis set (VBS) parameters were updated to reflect the generally higher SOA yields of phenolics relative to non-oxygenated aromatic compounds. The updated mechanism demonstrates improved accuracy in simulating the oxidation reactions of phenol and substituted phenols, including cresols compared to previous mechanisms, improving predictions of ozone levels and SOA formation.

9AC.21

Investigating the Aqueous Reaction of Vanillin with Nitrite under Dark Conditions - Kinetics and Brown Carbon Product Formation. FARIDEH HOSSEINI NAROUEI, Shiqi Ian Wang, Emily Baer, Juliana Marston, Hanie Tamandani, Yi Rao, V. Faye McNeill, *Columbia University*

Phenols, produced during biomass burning, have been shown to form light-absorbing secondary organic material, or Brown Carbon (BrC), in the atmosphere. This study investigates the transformation of vanillin into BrC compounds in aqueous solutions containing sodium nitrite and sodium nitrate, mimicking tropospheric aerosol particles. While other studies report the formation of BrC under similar conditions but in the presence of UV light, our study focuses on dark conditions. A visible color change was observed on a timescale of minutes, corresponding to the development of an absorption peak at ~440 nm. BrC formation kinetics were characterized using UV-Vis spectrophotometry. The reaction mixture was characterized using UPLC-QToF-MS and products identified include nitrated dimers and higher order oligomers of vanillin and other nitrated aromatic species. The products and kinetics will be presented and the potential mechanism will be discussed. These findings provide critical insights into the formation of organonitrate and BrC products from methoxyphenols.

9AE.2

Superoxide Release from Macrophages upon Exposure to Biomass Burning Aerosols, Plastic Combustion PM, Secondary Organic Aerosols, and Brake Wear Particles. KASEY EDWARDS, Rizana Salim, Ting Fang, Caitlyn Cruz, Sukriti Kapur, Sachin S. Gunthe, James Smith, Sergey Nizkorodov, Manabu Shiraiwa, *University of California, Irvine*

Oxidative stress induced by reactive oxygen species (ROS) is a key process for adverse health effects upon respiratory deposition of particulate matter (PM). Alveolar macrophages can release large amounts of superoxide upon phagocytosis of PM through a process called the respiratory burst. The release of cellular ROS should depend on both PM composition and dose, but the dose-response relationship for various types of PM remains unclear. Here, we quantify cellular superoxide generation by macrophage cells exposed to secondary organic aerosols (SOA) derived from $^{\bullet}$OH oxidation of limonene, toluene, and naphthalene, as well as primary organic aerosols (POA) from biomass burning, brake wear, and pyrolysis of five different types of plastics. We quantified cellular superoxide production over the span of five hours after initial exposure of cells to PM suspensions by applying a chemiluminescence assay combined with electron paramagnetic resonance spectroscopy. Limonene SOA was found to induce the largest amount of superoxide release, with an activation dose of 500 µg/mL. Naphthalene SOA, toluene SOA, and biomass burning aerosol showed minor enhancement of superoxide production, but had lower activation doses from 0.1-1 µg/mL. Plastic combustion PM showed a varied response depending on the type of plastic, with polyethylene terephthalate (PET) and high-density polyethylene (HDPE) having the highest observed superoxide production. The activation dose for plastic combustion PM was found to be between 10-100 µg/mL. Brake wear PM, on the other hand, led to immediate suppression of cellular superoxide release. Determining the activation dose and resulting cellular superoxide production of different types of PM provide critical insights for their relative inflammatory responses.

9AE.3

Air Pollution mAnagement and interVentIon Tool foR IndiA (PAVITRA): Making a Case for Multi-Scale Multi-Sector Air Quality Management.

LUCAS ROJAS MENDOZA, Srinidhi Balasubramanian, Neeldip Barman, Yuzhou Wang, Julian Marshall, Chandra Venkataraman, Joshua S. Apte, *University of California Berkeley*

India has one of the highest population-weighted mean (PWM) exposures to ambient $PM_{2.5}$ in the world. Comprehensive studies on the impact of transported $PM_{2.5}$ across multiple scales (e.g., regions, states, and cities) and sectors are limited. Despite evidence of long-range transport, India's National Clean Air Program (NCAP) remains largely city-centric, focusing on 131 non-attainment cities separately. The current framework stands in direct contrast to calls for a shift towards multi-scale, multi-sector air quality management.

While conventional chemical transport models have traditionally been used to map emissions to spatial-temporal predictions of air pollutants, they are computationally and time expensive. Here, we develop the PAVITRA (air Pollution mAnagement and interVentIon Tool foR IndiA) tool, which includes the SMoG-PAVITRA 5km-gridded emissions inventory across 19 economic sectors and InMAP-PAVITRA for South Asia, a reduced complexity model created from an optimized WRF-Chem simulation. The PAVITRA combination of models and emission inventory datasets lowers technical barriers and streamlines predictions of $PM_{2.5}$ concentrations at high spatial resolutions, enabling comprehensive evaluation of potential emissions scenarios.

We employ PAVITRA using a variable-sized grid (1 km to 60 km, based on population density), decomposing emissions by sector and across 6 regions, to calculate PWM $PM_{2.5}$ concentrations for primary $PM_{2.5}$ and four precursor species (NH_3, NO_x, SO_x, VOC). Results capture the spatial heterogeneity in PWM $PM_{2.5}$ exposures because of emissions profiles and sectoral contributions. We find that domestic, agriculture, energy, industry, and transportation sectors are major contributors to air pollution for all regions. Across regions, 60-80% of exposure is from within-region emissions; the rest (20-40%) comes from upwind emissions. For the city of Delhi, a key target of the NCAP's city-centered approach, within-city emissions account for less than 50% of exposure; this highlights the inadequacy of solely city-centered approaches in addressing $PM_{2.5}$ exposure, and the need for a multi-scale multi-sector approach.

9AE.4

Aerosol Resuspension from Firefighter Gear: A Potential Source of Firefighter Respiratory Exposure.

SHRUTI CHOUDHARY, Umer Bakali, Chitvan Killawala, Frank Pekora, Jonathan Robbins, Christopher Bator, Natasha Solle, Erin Kobetz, Alberto Caban-Martinez, Pratim Biswas, *University of Miami*

Firefighters are exposed to a variety of toxic aerosols and gases during fire trainings and on-duty fire calls. The International Agency for Research on Cancer reclassified firefighting as a group 1 carcinogen. Aerosols could be resuspended during non-decontaminated gear doffing and donning. Respiratory safety from Self Contained Breathing Apparatus could be compromised unintentionally. To the best of our knowledge this is the first study estimating the potential aerosol exposure by resuspension from firefighter gear and the efficacy of gross decontamination with soap and water solution . Additionally, the particulate matter (PM) exposure in fire trucks due to resuspension of aerosol from firefighter gear was also evaluated.

Aerosol measurements at a live fire training facility, and inside fire trucks during fire responding calls was done. First, we study the aerosol emissions from gear in a controlled study where firefighter don and doff the gear inside an enclosed chamber after live fire training. Scanning Mobility Particle Sizer and aerosol spectrometer are used to measure size distributions. Anderson eight stage impactor is used to collect size-resolved aerosols resuspended from the gear for chemical composition analysis. The potential exposure was estimated by using the ICRP (International Commission on Radiological Protection) respiratory deposition model. Second, the exposure in fire trucks due to aerosol resuspension from firefighter gear was determined using wearable particulate matter sensors.

Preliminary results suggest that aerosols are resuspended during gear doffing. The efficacy of gear decontamination after live fire training was 87% for total suspended particles and 70% for $PM_{2.5}$. The $PM_{2.5}$ concentration was as high as 140µg/m^3 in the fire trucks after the firefighter attended the fire call, where the potential source could be aerosol resuspension from firefighter gear. Post-fire decontamination procedures hold promise in the reduction of resuspended aerosols from gear. Future directions include estimating aerosol resuspension during gear donning.

9AE.5

Improved Indoor Air Quality in Vape Shops Associated With Business Pattern Shift: Impact of Tobacco Regulation in California.

HAOXUAN CHEN, Siri Langmo, Muchuan Niu, Yuan Yao, Yifang Zhu, *University of California, Los Angeles*

Vape shops have become widespread due to the rapid growth of the electronic cigarette (e-cig) market over the past decade. These establishments serve customers for purchasing and sampling e-cig products and also function as social spaces where vaping is permitted indoors. Our previous study revealed alarmingly high levels of fine particulate matter ($PM_{2.5}$) in vape shops, reaching levels as high as 276 µg/m3 during business hours due to extensive indoor e-cig use, which poses serious environmental and public health concerns. Prompted by the concerning popularity of flavored e-cigs among teenagers, California implemented a ban on the sale of flavored tobacco products in November 2022. To understand the impact of tobacco regulation in California on indoor air quality in vape shops, we conducted a follow-up study by recruiting more vape shops, including those previously studied, across Southern California to comprehensively evaluate the indoor air quality and characterize e-cig aerosols in vape shops.

Our results show a substantial decrease in vaping density in vape shops contributed by customers compared to the previous survey results, reflecting a shift in the business patterns where customers spend less time vaping in the shops. Additionally, the ventilation of the vape shops improved, as indicated by higher air exchange rates. Collectively, the $PM_{2.5}$ mass and particle number concentrations decreased significantly, but still remained times higher than the air quality standards. Vaping density serves as a strong predictor of particle concentrations. Ongoing work will analyze the nicotine and flavor compositions of PM to quantify contributions from e-cigs and flavored products. In addition, we will assess the environmental exposure risk to e-cig-sourced PM in vape shops based on lung deposition modeling.

This study provides novel insights into understanding the impact of tobacco regulation on protecting public health by reducing environmental exposures.

9AE.6

Exposure to Particulate and Gaseous Pollutants Inside Vehicles Parked in Intense Heat.

MINSEOK KIM, June Young Park, Insung Kang, *The University of Texas at Arlington*

Climate change is an urgent global threat, leading to the increasing frequency and intensity of extreme weather, including heat waves, which can make vehicle interiors dangerously hot. Elevated temperature and solar radiation can lead to the emission of harmful air pollutants such as VOCs and PM from interior materials, which can cause numerous adverse health effects. Therefore, this study investigates the emission rates of these pollutants in vehicles parked under such intense heat conditions. To measure the indoor environment of different types of vehicles, we will select an outdoor parking lot at the University of Texas at Arlington, which is directly exposed to solar radiation. Time-series indoor concentrations of VOCs, PM, ozone, and other environmental factors (e.g., temperature, humidity, solar radiation) will be measured in approximately 20 vehicles of different years, brands, and sizes. We will use the mass balance equation to calculate the emission rates inside each vehicle during peak temperature hours. The baseline measurement will be preceded by open windows and A/C system operation for 30 minutes to standardize the experimental conditions and establish baseline steady-state air pollution and temperature levels. We hypothesize that vehicular conditions exposed to intense heat would stimulate an acceleration in the emission rate of VOCs and PM, as well as the formation of ozone potentially through photochemical processes. Our findings can contribute to underscoring the significance of public awareness in addressing health risks associated with in-vehicle air pollution during the summer months. Furthermore, future research will investigate the decay of emission rates for air pollutants by applying mitigation strategies, including opening windows, operating A/C systems, parking in shaded areas, and using sunshades under intense heat conditions during summer.

9AE.7

Mercury Vapor Emission during Dental Amalgam Removal: A Comprehensive Assessment of Atmospheric Concentrations through Direct and Indirect Measurement Techniques. JÉRÔME DEVOY, *French National Institute for Research and Safety, France*

This study delves into the release of mercury vapor during dental amalgam removal procedures and employs both direct (LUMEX) and indirect (hydrar tube) techniques to measure atmospheric mercury concentrations. Dental amalgam, a composite of elemental mercury, silver, tin, and copper, undergoes mechanical and thermal forces during routine removal, resulting in the generation of fine particulate matter. This disturbance exposes liquid mercury to the air, leading to the volatilization of mercury vapor.

Utilizing high-speed drilling and other mechanical interventions, small particles are created, significantly increasing the surface area for mercury vapor release. The study involves a comparative analysis of atmospheric mercury concentrations measured directly using LUMEX and indirectly through hydrar tube methods during dental amalgam removal. This approach provides a nuanced understanding of the mercury release dynamics.

The results highlight the potential health risks associated with inhalation exposure, emphasizing the need for accurate measurement techniques.

Although there is a non-zero ambient concentration (10-150 ng/m3), the peaks of mercury concentration occur when opening the vials containing the mercury capsules (>20 µg/m3), when milling the dental amalgam (150-350 ng/m3) and when cleaning the work space (>20 µg/m3).

Chronic exposure to mercury vapor is known to have adverse health effects, particularly on the nervous system. Safety measures implemented by dental practitioners, such as high-volume suction, rubber dam isolation, and protective masks, are considered in conjunction with the measured mercury concentrations.

This study underscores the significant role of dental amalgam removal as a source of mercury exposure while offering a dual perspective through direct and indirect measurement techniques. Guidelines from dental organizations and health agencies, coupled with ongoing discussions in the dental and medical communities, underscore the importance of comprehensive strategies to mitigate mercury exposure risks. The comparative analysis of direct and indirect measurement results contributes valuable insights, aiding in the development of informed practices and policies in dental settings.

9AE.8

County-Level Influenza Risk Mapping: Assessing the Impact of PM2.5 and Socioeconomic Factors. SHRABANI TRIPATHY, Joseph V. Puthussery, Taveen Kapoor, Rajan K. Chakrabarty, *Washington University in St. Louis*

Seasonal influenza outbreaks occur annually across the USA, resulting in hospitalizations, fatalities, and substantial economic repercussions. Centers for Disease Control and Prevention (CDC), USA estimates that flu has resulted in 9.3 – 41 million illnesses and 4,900 – 51,000 deaths annually between 2010 and 2023. While influenza can affect individuals of any age group, certain populations are more susceptible to infection and severe disease. Recent research has linked air pollution, particularly PM2.5, with increased rates of influenza infection, establishing it as a potential determinant of influenza transmission. There has also been a link between socioeconomic factors and influenza, causing the disproportionate burden and suffering of the poor due to unequal conditions. However, the relative impacts of these parameters on infection outbreaks remain unclear. To address this gap, we employ a machine learning-based approach to assess the relative influence of various socio-economic parameters and annually averaged PM2.5 levels on influenza outbreaks. We quantify the extent of interrelation between these factors and influenza risk by analyzing over 150 different indicators—including population demographics, race, household information, insurance coverage, income, etc. The method assigns each indicator's relative degree of influence with the influenza infection rate at each county and helps identify the most important factors.

The resulting data is used to generate a county-level risk index for the contiguous United States (CONUS). These risk maps identify regions with elevated risk and highlight the contributing factors to higher risk in specific counties. Risk quantification helps identify major contributors to the total risk associated with a particular county, enabling the adoption of specific mitigation strategies to minimize risk. The easily interpretable results provided by these maps are invaluable for stakeholders and policymakers, highlighting disparities in health outcomes and aiding in targeted intervention and resource allocation to mitigate the impact of seasonal influenza.

9AE.9

Elucidating Industrial Pollution Impacts on Disadvantaged Neighborhoods of Santa Ana. SUKRITI KAPUR, Jasmine Osei-Enin, Andrea Delgado, James Adams, Leonel Flores, Jose Rea, David Herman, José Arturo Jiménez Chávez, Celia Faiola, Manabu Shiraiwa, Andrea De Vizcaya Ruiz, Michael Kleinman, Jun Wu, Kathleen Johnson, Kim Fortun, *University of California, Irvine*

Santa Ana, California faces a large environmental burden of poor air quality due to proximity to industrial facilities. The city has ~1700 permitted facilities that emit large quantities of toxic metals, volatile organic compounds and particulate matter. More than 33 out of 64 neighborhoods are designated as disadvantaged communities on CalEnviroScreen. Getting Residents Engaged in Empowering Neighborhoods - Madison Park Neighborhood Association (GREEN-MPNA) is a community-based organization in Southeast Santa Ana that advocates for clean and safe environments, and community empowerment through active civic participation. Its Comunidad Unida Aire Limpio (CUAL) committee is a resident-driven air monitoring network and environmental justice steering committee that is active in clean air advocacy and community research. CUAL utilizes a multifaceted approach to advocate for clean air: 1) advocacy through stakeholder meetings 2) community air monitoring, and 3) capacity building to empower communities for long term self-sufficiency in air quality management. GREEN-MPNA (in partnership with EcoGovLab, UCI) organizes bi-annual stakeholder meetings, bringing together regulatory agency representatives to discuss issues of concern with the community such as proximity to metal plating industries, lead and hexavalent chromium pollution, and lack of a monitoring station nearby. These meetings have paved the way for active advocacy by residents and researchers alike. Through air monitoring we investigated how proximity to local industries affects indoor air quality in East Santa Ana homes by comparing indoor and outdoor $PM_{2.5}$ concentrations. The result showed higher indoor concentrations in homes closer to the industrial corridor. To foster long-term capacity building in Santa Ana, CUAL implements several initiatives, including year-round educational programs for various age-groups, university campus visits for students, and guided tours of environmental justice communities throughout California. Collectively, these efforts have helped the community and researchers understand the magnitude of poor air quality in Santa Ana, and subsequent steps needed to address this problem.

9AE.10

Characterization of Airborne Metagenomics across Major United States Metropolitan Areas. VIVIAN TAT, Kostiantyn Botnar, Sean Kinahan, Shanna A. Ratnesar-Shumate, Madison Farnsworth, Sarah Alnemrat, Justin Nguyen, David Kimmel, Hema Narra, Christine Tomlinson, George Golovko, Kamil Khanipov, *The University of Texas Medical Branch*

Despite public health and biosurveillance advances, emerging and endemic infectious disease outbreaks continue to impact regional and global health systems, and the systems remain largely reactionary to symptomatic cases. Pre-symptomatic surveillance of bioaerosols and pathogens is crucial to understanding, preventing, and controlling future outbreaks transmitted through the air and in detecting novel pathogens.

We have collected more than 600 high-volume air filters from over 140 indoor and outdoor locations across the United States. These teflon (PTFE) air filters collectors are located in major metropolitan areas and are collected at over 100 liters per minute during different seasons, beginning in January 2024. Our team evaluated and cross-compared nucleic acid extraction kits, including the DNeasy PowerSoil Pro, DNeasy PowerWater, ZymoBiomics DNA/RNA Miniprep, and MagMax Viral Ultra. Additionally, six cDNA synthesis approaches were evaluated using, including SuperScript kits, Maxima H Minus, iScript, and Oxford Nanopore Technologies cDNA conversion, as well as a variety of second strand conversions. The sample preparation approaches were evaluated using Qubit, BioAnalyzer 2100, Nanodrop 2000, and through results of DNA/RNA sequencing.

We determined that there were differences in the microbial composition of indoor and outdoor environments, depending on time point collected, and we are working on establishing the background air microbiome. The resulting raw sequencing data, basecalls, sample metadata, and bioinformatic pipelines for environmental aerosol collector are being shared to a public repository. The development of systems capable of discriminating between background aerosols and biological incidents such as novel pathogens, especially at low incidence rates, has been a substantial challenge for deployment of bioaerosol detection systems. Understanding unique and evolving outdoor and indoor microbiome environments will allow us to better identify hazardous anomalies and changes affecting human health.

9AP.1

Integrating Ion-Mobility and MD Simulations with Enhanced Sampling Techniques to Characterize Gas-Phase Compaction of Protein Structures. VIRAJ GANDHI, Carlos Larriba-Andaluz, *Purdue University*

This work addresses significant challenges associated with characterizing protein structures in the gas phase. The compaction of proteins in the gas phase is a phenomenon that is widely acknowledged and observed experimentally. However, there are no theoretical and simulation approaches that truly explain the process. Among the possible reasons, two stand out, the first is because most forcefields are optimized in aqueous environments and the second is because the timescale to cover such broad ergodic spaces is too large to sample every scenario. Our contribution lies in extending molecular dynamics(MD) simulations beyond conventional approaches, using enhanced sampling techniques such as Adaptive Biasing Forces to navigate the protein's configuration space more effectively so reaching the equilibrium gas-phase structure observed experimentally. Collision cross-sections (CCS) of six different proteins (Immunoglobulin, Concanavalin, BSA, PK, SAP, and AD) were experimentally measured and found to align with literature values. Contrarily, structures generated through unbiased MD simulations in the gas-phase produced CCS values 10-30% larger. To reconcile this discrepancy, a harmonic biasing potential in the direction of the radius of gyration was employed to efficiently map all possible configurations which might be hidden behind energy barriers not easily bypassed. Periods alternating between applied-force and force-free intervals, akin to simulated annealing, are employed. Upon force application, a significant decrease in CCS was observed, indicative of instantaneous compression. During subsequent force-free intervals, relaxation was noted without reverting to unbiased values, suggesting the attainment of more compact configurations. With successive cycles, the CCS during the force-free intervals gradually stabilizes, reaching an equilibrium value. Convergence was achieved regardless of the strength of the force applied, and the convergence CCS was within ~4% of the experimental CCS for different charge states. The protein structures tend to become globular, even for the Y-shaped immunoglobulin, which seems a likely outcome under capillarity effects.

9AP.2

Influence of Drying Rate on Morphology of Laboratory Generated Sodium Chloride Aerosols. NISHAN SAPKOTA, Rym Mehri, Timothy Sipkens, Steven Rogak, Joel Corbin, *University of British Columbia*

Sodium chloride (NaCl) aerosols play an important role both in nature as sea-spray particles and in the laboratory as a calibration source. However, characterizing these aerosols is often difficult as they show significant variation in their shape, ranging from spherical to cubic depending on the drying rate. Drying rate influences particle morphology as it governs the nucleation rate of NaCl crystals; with extremely slow and fast rates resulting in monocrystalline cubes or polycrystalline spheroids, respectively. This work, therefore, builds on the current literature by establishing the influence of drying rate on the distribution of effective density and dynamic shape factor of laboratory generated NaCl particles. A TSI 3076 atomizer was operated to generate NaCl particles that are passed through a polytube Nafion dryer. Flow rates in the dryer were varied to control the drying rate according to a quantitative theoretical framework. The dried particles were then passed through a tandem Centrifugal Particle Mass Analyzer and differential mobility analyzer (tCPMA-DMA) setup to classify with respect to both mobility equivalent diameter and particle mass. Morphological information was validated with TEM images. The results showed that slow-dried particles attained a more cubical shape with a lower effective density while fast-dried particles retained their spherical morphology with a higher effective density.

9AP.3

Secondary Organic Aerosol from Reactions of Biomass Burning Phenolic Compounds with Nitrate Radicals (NO3) Can Be Highly Viscous and Even Glassy over a Wide Relative Humidity Range due to Limited Hygroscopicity. SEPEHR NIKKHO, Bin Bai, Fabian Mahrt, Julia Zaks, Long Peng, Kristian Kiland, Pengfei Liu, Allan K. Bertram, *University of British Columbia*

Biomass burning events, including wildfires, can emit large amounts of phenolic compounds, such as guaiacol, into the atmosphere. Once in the atmosphere, phenolic compounds can be oxidized by nitrate radicals (NO_3) to form secondary organic aerosol (SOA). Viscosity and hygroscopicity are two important properties of SOA since they influence several atmospheric processes including particle reactivity, particle growth, and cloud nucleating ability. However, the viscosity and hygroscopicity of SOA generated from phenolic compounds and NO_3 have not been quantified. In the following, we use the poke-flow technique to measure the RH-dependent viscosity of SOA particles generated by reacting guaiacol and NO_3, referred to as guaiacol-NO_3 SOA. We also measured the hygroscopicity of the guaiacol-NO_3 SOA to better understand the RH-dependent viscosity measurements. We found that the viscosity of guaiacol-NO_3 SOA is high ($\gtrsim 5\times10^7$ Pa s) at RH values $\lesssim$ 70%. For reference, the viscosity of tar pitch is ~10^8 Pa s. Even at 80% RH, the viscosity is still 6×10^5 Pa s. In addition, the viscosity of guaiacol-NO_3 SOA is drastically higher than the other types of SOA studied with the poke-flow technique at $\gtrsim$ 40% RH. The difference between the viscosities of guaiacol-NO_3 SOA and the other types of SOA can be explained, at least in part, by a low hygroscopicity parameter for guaiacol-NO_3 SOA. We extrapolated our results to lower temperatures using the Vogel-Fulcher-Tammann equation. Based on this extrapolation, guaiacol-NO_3 SOA is most often in a semi-solid state in the planetary boundary layer ($\lesssim$ 1 km in altitude) and a glass state in the free troposphere (1km $\lesssim$ altitude $\lesssim$ 18 km). The liquid state is only predicted for a very small region of the planetary boundary layer ($\gtrsim$ 80 ° latitude).

9AP.4

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.

9AP.5

Measurements of the Physical Decay Rates of Aerosols in a Rotating Drum. DEEPAK SAPKOTA, Hui Ouyang, *University of Texas at Dallas*

Rotating drums have been extensively used in the retention of aerosols for longer duration of time for various applications including bioaerosols transmission, inhalation toxicology, immunology, and drug delivery. Particularly, it is important to accurately quantify the physical decay rate (the deposition rate of particles to the wall) for bioaerosol studies, to improve accuracy for the biological decay of airborne pathogens. In this study, we focus on measuring the physical decay rates spanning from nanoparticles to sub-10 µm particles and subsequently compare the experimental findings with existing theoretical models. Polydisperse aerosols of KCl, generated using a 4-jet BLAM nebulizer, are introduced into a 40L Goldberg rotating drum, where they remain suspended for a duration of five hours. To prevent coagulation between nanoparticles (<1µm) and larger sub-10 µm particles, we employ a virtual impactor to introduce nanoparticles or larger particles separately into the drum during loading. The number concentration of aerosols inside the drum was measured with SMPS (Scanning Mobility Particle Sizer- TSI) for nanoparticles and APS (Aerodynamic Particle Sizer -TSI) larger sub-10 µm particles. The decay rates, represented by k (#/second), in an exponential decay model (the number concentration decays exponentially with time) are dependent on particle size. Interestingly, they follow a U-shape pattern with the particle size: for nanoparticles, the decay rate increases as particle size decreases, while for sub-10 µm particles, it increases as particle size increases. Comparative analysis of measurements with diverse theoretical models suggests that turbulent diffusion primarily governs particle loss for nanoparticles, while inertia becomes significant for sub-10 µm particles. Given the absence of accurate models covering both nano- and micro-size particle loss in the rotating drum, this study sets the stage for developing an improved model to characterize particle loss under varying operating conditions of the rotating drum.

9AP.7

Exploring Aerosol Properties and Boundary Structures Using the ArcticShark UAS: Insights from the Southern Great Plains. FAN MEI, Qi Zhang, Jerome Fast, Mikhail Pekour, Christopher Niedek, Zihua Zhu, Damao Zhang, Beat Schmid, Jason Tomlinson, Zezhen Cheng, Swarup China, Gourihar Kulkarni, Gregory W. Vandergrift, Nurun Nahar Lata, Susanne Glienke, Hardeep Mehta, Xena Mansoura, *Pacific Northwest National Laboratory*

This study presents multiple deployments leveraging a mid-size Unmanned Aerial System (UAS), the ArcticShark, to probe aerosol properties and boundary structures over the Southern Great Plains (SGP) in 2023. Focusing on aerosols, we integrate the spatiotemporal data from in situ measurements and remote-sensing technology to offer valuable comparisons and reveal the consistency and complementarity of these methodologies.

Additionally, we obtained unique chemical composition profiles using advanced offline chemical analysis techniques during March, June, and August 2023. By studying seasonal variations in aerosol properties and boundary structures, we correlated them with the potential influential sources. These findings advance our comprehension of SGP's vertical atmospheric layers and highlight ArcticShark UAS's versatility as a comprehensive atmospheric research tool. This research has significant implications for advancing our knowledge of vertical gradient of atmospheric aerosols, enhancing air quality monitoring strategies, and informing aerosol transport models.

9AP.8

How Many ODEs are Required to Describe Multicomponent Aerosol Evaporation in Vapor-free Conditions?

ANDREY KHLYSTOV, *Desert Research Institute*

A novel theoretical framework describing the evaporation of individual compounds from an aerosol in vapor-free conditions will be presented, demonstrating that the evaporation of mixture components is interconnected via the ratio of their characteristic times. These characteristic times are proportional to the square of the initial particle diameter and inversely proportional to the compound saturation vapor concentration (SVC). A single ordinary differential equation (ODE) is sufficient to describe the behavior of all mixture components. It is shown that the time needed to evaporate a specific compound fraction is primarily controlled by the compound's characteristic time, with lesser influences from compound abundance in the mixture and the amount of less volatile material. Consequently, the relative abundance of individual compounds has a minor effect on evaporation. Compounds evaporate in the reverse order of their SVC, with the time required to evaporate 50% of their original mass being roughly half of their characteristic time. The reduction in ODEs provides significant computational benefits. Additional simplifications are derived that further accelerate calculations by two orders of magnitude while maintaining accuracy. The theory can guide experimental design for aerosol volatility measurements and demonstrate that a unique volatility basis set (VBS) can be fit to experimental data if the number of observations equals at least the number of volatility bins minus one. However, assumptions regarding parameters used for VBS fitting can result in ambiguity in the derived VBS, making it essential to use the same parameters for modeling evaporation as those used to derive the VBS from experimental data.

9AP.9

Electron Microscopy Imaging of Lab-generated Aerosol Particles.

Amrita Chakraborty, Deepak Sapkota, Yuhui Guo, James Hu, Harris Xie, Ian Wu, Zhenpeng Qin, HUI OUYANG, *University of Texas at Dallas*

It is important to characterize the structure and compositions of aerosol particles for aerosol transport applications, such as bioaerosols and atmospheric aerosol transport. In this study, we develop an experimental imaging approach that can pave the way to probe the microenvironmental conditions of desiccated bioaerosols with various chemical compositions. Starting with the salt solutions (KCl and NaCl), a BLAM nebulizer is used for aerosolization. Aerosol particles are dried and collected onto Silicon wafers and TEM grids, which sit onto the impaction plates in a standard 8-stage Andersen impactor. Particles with different sizes are collected at different stages for scanning (SEM) and scanning transmission electron microscopic (STEM) imaging, respectively. Further, STEM energy dispersive X-ray spectroscopy measurements are performed to reveal the elemental distribution in the bioaerosol. The results show that salts deviate from spherical structures and form crystals instead under the low relative humidity condition (RH = 30%). Elements mapping also shows a separation between Na and K when a solution of the mixture of NaCl and KCl is aerosolized together. Separation is also presented when aerosolizing salt and Bovine serum albumin (BSA) protein. Adding organics will shift the structure towards spherical shape. Our study reveals morphological insight into aerosol particles under different composition and sizes.

9BA.1

Bioaerosols and Water Respiratory and Gastrointestinal Viruses in Wastewater Treatment Plants.

ÉMIE LACHANCE, Arthur Ouradou, Salim Khaddouma, Marc Veillette, Émilie Bédard, Caroline Duchaine, *Université Laval*

Several processes within wastewater treatment are sources of bioaerosols, potentially containing various pathogens such as viruses responsible for respiratory and gastrointestinal illnesses. Although the occupational exposure of workers to bioaerosols has been demonstrated repeatedly, the existing link between viruses contained in bioaerosols and in wastewater is not well understood. To better understand the contribution of water, aerosolization process and nature of the potential exposure by these workers, ambient concentrations of specific viruses in the bioaerosols and the treated wastewater were assessed. Fifteen different wastewater treatment plants were visited during summer period. Respiratory and gastrointestinal viruses (rotavirus, adenovirus and rhinovirus) were quantified using qPCR. For each air sample collected, a wastewater sample was also taken to determine source concentrations, verify the existence of a correlation and calculate a spray factor. At present, rhinovirus and rotavirus have either not been detected or have been detected in low levels. These preliminary results can be explained by the generally lower frequency of infections with these viruses during the summer season. However, adenovirus was detected in air samples with a frequency of 32% at an average concentration of 6.99x103 copies/m3, and in wastewater samples with a frequency of 69% at an average concentration of 1.5x107 copies/m3. No correlation could be established between the different concentrations detected in the air and in wastewater, suggesting complex aerosolization processes. These results will later be combined with the ambient concentrations of other pathogens as well as the detection of serum IgG antibodies specific to immunogenic agents to evaluate occupational exposure in wastewater treatment plants. All these findings will be instrumental in establishing new measures aimed at reducing the exposure of wastewater treatment plant workers to bioaerosols.

9BA.2

Viral Preservation with Saliva Mimicking Medium in Aerosols.

Brittany Humphrey, Matthew Tezak, Mia Lobitz, Anastasia Hendricks, Andres Sanchez, Jake Zenker, Steven Storch, Bryce Ricken, Ryan D. Davis, JESSE CAHILL, *Sandia National Laboratories*

The outbreak of SARS-CoV-2 has emphasized the need for a deeper understanding of infectivity, spread, and treatment of airborne viruses. Bacteriophages (phages) serve as ideal surrogates for respiratory pathogenic viruses thanks to their high tractability and the structural similarities tailless phages bear to viral pathogens. However, the aerosolization of enveloped SARS-CoV-2 surrogate phi6 usually results in a >3-log10 reduction in viability, limiting its usefulness as a surrogate for aerosolized coronavirus in "real world" contexts, such as a sneeze or cough. Recent work has shown that saliva or artificial saliva greatly improves the stability of viruses in aerosols and microdroplets relative to standard dilution/storage buffers like suspension medium (SM) buffer. These findings led us to investigate whether we could formulate media that preserves the viability of phi6 and other phages in artificially derived aerosols. Results indicate that SM buffer supplemented with bovine serum albumin (BSA) significantly improves the recovery of airborne phi6, MS2, and 80α and outperforms commercially formulated artificial saliva. Particle sizing and acoustic particle trapping data indicate that BSA supplementation dose-dependently improves viral survivability by reducing the extent of particle evaporation. Our data aligns with others' findings, which suggest that soluble protein is a key protective component in nebulizing medium. Protein supplementation likely reduces exposure of the phage to the air-water interface by reducing the extent of particle evaporation. These data suggest that our viral preservation medium may facilitate a lower-cost alternative to artificial saliva for future applied aerobiology studies, for applications in which researchers wish to improve the survivability of these (and likely other) aerosolized viruses to better approximate highly transmissible airborne viruses like SARS-CoV-2.

9BA.3

Viral Filtration Efficiency: Impact of Washing on Reusable Masks.

VINCENT BROCHU, Nathalie Turgeon, Marc Veillette, Caroline Duchaine, *Université Laval*

Introduction

During the Sars-CoV-2 pandemic, single-use masks were heavily used to reduce the spread of the virus in the community. From an environmental perspective, reusable masks present a potential alternative to single-use ones. However, the effect of washing on the viral filtration efficiency of reusable masks is not well documented.

Methods

On a test bench simulating the dispersion of viral aerosols ranging from 29 to 5000 nm, particulate, and viral filtration efficiencies were evaluated for five reusable masks (Frëtt Solutions, Quebec, Canada): eAir, ePro, eTech V, eMed, and eMed 3. Those patented masks are made with polypropylene layers. Masks were placed one at a time on the test bench. Aerosols were generated from a buffer suspension containing ϕX174 viruses. Viral aerosols passed through the filter at an airflow rate of 85L/min. Particle counters and air samplers were placed upwind and downwind of the mask. Particles were counted and infectious viruses were quantified upwind and downwind to calculate the filtration efficiency for both particles and viruses. Each reusable mask was tested in triplicate for each washing cycle frequency (0x, 1x, 25x, 50x, 75x, and 100x).

Results and Discussion

Washing exerted a significant influence on filtration efficiency, with efficiency loss observed even after a single wash, further declining with additional washing cycles. Following a hundred washing cycles, the eAir mask exhibit the least resilience, experiencing a 25% reduction in efficiency against viruses. Conversely, the eMed 3 mask demonstrated the highest resistance, with only a 7% efficiency loss. Notably, a decries in filtration efficiency for particles smaller than 1 µm was also observed. Further investigations could explore the impact of alternative washing methods on the filtration efficiency of reusable masks.

Acknowledgment

Thanks to Frëtt Solutions for the masks

9BA.4

Biological Collection Efficiency of a Condensation-Based Bioaerosol Sampler.

MOHAMMAD WASHEEM, Amin Shirkhani, William B. Vass, Sripriya Nannu Shankar, Nohhyeon Kwak, Jiayu Li, Z. Hugh Fan, John Lednicky, Arantzazu Eiguren-Fernandez, Chang-Yu Wu, *University of Miami*

The biological collection efficiency (BCE) of bioaerosol samplers is crucial for accurate assessment of viable airborne pathogen threats. Condensation based aerosol samplers like Biospot-VIVAS (Viable Virus Aerosol Sampler) demonstrate >95% physical collection efficiency (PCE) for particles sized 10 nm to 10 µm and conserve viable viruses. However, the BCE of the VIVAS remains unknown. Determination of BCE is complex due to factors causing viability losses between aerosol generation and sample collection, leading to uncertainty about viable virus concentrations at the sampler inlet, which can bias results. We connected two identical VIVAS systems in series to address this issue. This arrangement allowed the determination of inlet concentrations of viable viruses, and by comparing them, we ascertained the VIVAS' BCE. MS2 bacteriophage was aerosolized using a Collison nebulizer and collected with the VIVAS systems over varied sampling durations and inlet concentrations. Particle size distributions were monitored using a Scanning Mobility Particle Sizer. The virus collected by the samplers was quantified by plaque assay and RT-qPCR. The PCE measured during the aerosolization of 0.5 µm polystyrene latex (PSL) particles exhibited a quadratic relationship to inlet particle concentration in which the PCE decreases with increased particle concentration. The plaque assay results for BCE indicated that VIVAS was 99.2% biologically efficient across sampling durations of 10, 20, and 30 minutes without statistically significant difference ($p > 0.05$) when the inlet concentration was held at 5×104±1×104 particles/cm3. When particle concentrations were held between 5×104 and 5×105 particles/cm3, the BCE was 98%. At particle concentrations >106 particles/cm3, the BCE fell to 90%. It indicates BCE of VIVAS also depends on particle concentration as PCE, but it does not drop as much at high concentration. This information will be useful for calibrating other bioaerosol samplers against VIVAS.

9BA.5

Advancing Near-Real-Time Metabolic Profiling of Airborne Bacteria. EMILY KRAUS, Bharath Prithiviraj, Jin Seo, Mark Hernandez, *University of Colorado Boulder*

Deciphering mechanistic responses underpinning microbial survival in air is indispensable toward understanding their persistence in the atmospheric environment. High-throughput microbial mRNA sequencing can generate a transcriptome to ascertain metabolic activity within an aerosol as it is collected. Transcriptomic studies of bioaerosols must carefully preserve mRNA to overcome significant challenges associated with the low levels of bacterial biomass typically found in air, as well as the rapid turnover of mRNA within cells. We developed methods to collect and extract RNA from live airborne microorganisms for transcriptomic studies while minimizing experimental artifacts during aerosolization, collection, and subsequent sample handling. *Mycobacteria* (gram +) and *Pseudomonas* (gram -) spp. harvested during log phase growth (ca. 10^9 CFU/mL), were aerosolized under temperature-controlled conditions into respirable particle sizes within a $10m^3$ chamber under environmentally controlled conditions, and subsequently collected via condensation in 5 minute sampling intervals directly into an RNA preservative. Bacterial strains differed in their airborne persistence over the course of an hour both between and within genera tested. Total RNA quantities recovered for *Mycobacterium crocinum* ranged from 300 – 460 ng over 5, 15, and 25 minutes of suspension at 60% RH, while *Pseudomonas syringae* yielded 365 ng of total RNA after 5 and 30 minutes airborne under otherwise identical conditions. The developed methodology can be easily adapted for any liquid nucleic acid preservative and desired atmospheric conditions, and, if needed, to include concomitant viability studies (either by cultivability or propidium monoazide qPCR). With these pilot studies and methodological developments, we present recommendations for advancing bioaerosol metabolic profiling while minimizing pervasive experimental artifacts and challenges inherent to both high-fidelity mRNA collection and bioaerosol experiments with low biomass samples. These results may assist in better mechanistic assessments of engineering interventions that can selectively inactivate live bioaerosols in relevant scenarios.

9BA.6

A Blueprint for the Use of Far-UVC to Suppress Airborne Transmission and Prevent Future Pandemics. Richard Williamson, JAMES MONTAVON, Rose Hadshar, Harry Koos, Jacob Swett, *Blueprint Biosecurity*

Our forthcoming summary, technical evaluation, and roadmap for far-UVC disinfection of aerosolized pathogens disentangles the challenges and uncertainties across technical domains, and synthesizes them into a research program addressing key scientific, technological, and sociological uncertainties.

We performed extensive literature reviews and over 100 semi-structured interviews across multiple fields, including disinfection efficacy, photobiological safety, and atmospheric chemistry. These were complemented by parametric modeling based on the Wells-Riley infection risk framework to quantify and contextualize our assessments.

Our findings prioritize immediate research on far-UVC's real-world efficacy for pathogen inactivation and transmission suppression. We demonstrate that equivalent clean airflow targets for infection risk management (ECAi) recommended by American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 241 ought to be achievable for some airborne pathogens of public health concern. However, this analysis is highly sensitive to current uncertainties in inactivation efficiency and the fluence rates realistically achievable within photobiological safety limits. Suppressing highly transmissible pathogens over longer periods of exposure may require ECAi in excess of existing recommendations.

Further uncertainties exist in several domains, including how photochemical reactions affect materials and other common indoor chemicals, whether exposure limits need modification for particularly vulnerable groups, and the effects of disinfection on the beneficial elements of the indoor microbiome. We outline areas that require additional research prior to widespread implementation.

Our work elucidates a multidisciplinary research program for the application and development of far-UVC technology. Continued interdisciplinary studies and advancements are essential to address the identified uncertainties and to integrate far-UVC solutions into public health strategies for safer indoor environments and pandemic prevention.

9BA.7

Novel Passive Sampler to Assess Personal Exposures to Airborne Biological Agents. Taewon Han, GEDIMINAS MAINELIS, *Rutgers, The State University of New Jersey*

We present the development and testing of a novel passive sampler capable of measuring personal exposures to airborne infectious agents, including individual viruses, virus-laden droplets, and virus-particle agglomerates. There are no passive personal bioaerosol samplers, and they offer obvious advantages over active methods – no need for pump and power supplies. We previously developed and applied a stationary Rutgers Electrostatic Passive Sampler (REPS), where airborne biological agents are captured on a specially configured poly(vinylidene fluoride) (PVDF) film. Here, we used the same concept and designed a personal version of the sampler that attaches to clothing within an individual's breathing zone. Inside this personal sampler (P-REPS), the permanently polarized ferroelectric film PVDF is placed in a holder and wound in a spiral configuration so that the film surfaces with opposing polarization face one another and are spaced 2.25 mm apart to create a sufficiently strong electrostatic field between the layers. We built several P-REPS prototypes with a 35 mm-wide base but different heights (1 in and 0.5 in) and investigated particle elution protocols with varying elution volumes (10-70 mL). The capture efficiency of the P-REPS models was tested with Staphylococcus epidermidis in a vertical settling chamber against a 37 mm PTFE filter, and the microorganisms were determined by acridine orange epifluorescence microscopy and ATP methodology; P-REPS was also tested at 0 and 90 degrees to the vertical. The number of spores captured by the 1-inch P-REPS exceeded the number of particles collected by a settling filter by a factor of ~3, indicating the effectiveness of the passive electrostatic capture mechanism. Current testing of the P-REPS compares it against an active low-flow sampler in chamber studies when collecting multiple microorganisms. Overall, the concept shows great promise as another tool to measure exposure to airborne microorganisms.

9BA.8

Improving Water Condensation Bioaerosol Sampling Using a Concentrated Sample Inlet Flow. DREW JONES, Mark Hernandez, Marina Nieto-Caballero, Sonia Kreidenweis, Shantanu Jathar, *Colorado State University*

Bioaerosols can be collected with high efficiency using water condensation capture samplers, (e.g., BioSpot-VIVAS and BioSpot-GEM, Aerosol Devices), while avoiding certain challenges presented with filter-based collection such as sample desiccation and incomplete recovery of sampled bioaerosol during subsequent sample elution. Despite their high collection efficiency, these samplers have low collection flow rates (≤15 LPM) compared to other types of samplers, possibly limiting their utility when sampling in environments with low ambient concentrations of bioaerosols (e.g., outdoor settings). Concentrating the sampled airstream using a virtual impactor in the instrument's inlet may solve the challenge of low sampler flow rates.

In this study, a multi-jet virtual impactor was designed and fabricated based on design parameters from published work by F. J. Romay et al. The cut-point and concentration factor of the virtual impactor were characterized using a range of monodisperse aerosols in a chamber study. The virtual impactor was then integrated into the inlet flow path of a water condensation capture sampler (BioSpot-VIVAS). Additionally, a chamber study with model bioaerosols is planned to compare the collection ability of the virtual impactor augmented sampler with an unmodified sampler. We hypothesize that the virtual impactor in line with the sampler will allow for effective flow rates ranging from ten to twenty times greater than those from the commercially available sampler, translating to ten to twenty times more bioaerosol collection in the same sampling time. This work will help improve bioaerosol collection for aerobiome studies (e.g., metagenomics, and metatranscriptomics), particularly those performed in low bioaerosol concentration environments.

9BA.9

Isolating the UV222 Inactivation Responses of Common Airborne Allergens at Different Relative Humidity Levels. MARK HERNANDEZ, *University of Colorado at Boulder*

Airborne allergens pose unique indoor air quality challenges; of these, dust mites, molds, pollen, and pet dander are sources for a variety of immunogenic antigens. These allergens can trigger allergenic and hypersensitivity responses in the eyes, nasal passages, and lungs. Allergen protein conformation is specifically recognized by the mammalian immune system, resulting in a broad variety of atopic responses where the allergen structure is essential in facilitating pro-inflammatory functions; thus, bioaerosol intervention methods that act to disrupt allergen protein conformation represent new treatment strategies for reducing the negative health effects associated with allergen exposure through the route of inhalation. In this context, we report here that UV222 exposures can reduce allergens in an airborne state as measured by immunoassays, which rely on the intact protein structure for quantification.

Full-scale chamber studies were conducted to assess the denaturing effects known doses of UV222 had on the protein conformation of the following allergens in an airborne state: Der p1, Der f1, Asp f1, Can f1, Fel d1, Phl p5, and Bet v1. These allergens were aerosolized in a respirable size range and contained, well-mixed, humidity-controlled chambers (1 m3 and 10 m3) samples of which were collected in time-series using condensation growth tube BioSpot samplers. Aeroallergens were measured by ELISA (Enzyme-Linked Immunosorbent Assay) or MARIA (Multiplex Array for Indoor Allergens), both of which utilize widely accepted antibody-based allergen epitope recognition.

Aerosols recovered in the presence of UV222 showed a decrease in aeroallergen half-life following as early as 20 minutes of exposure to UV222 when compared to otherwise identical chamber experiments without UV222. These results suggest that UV222 may be applied to inactivate airborne allergens by disrupting their conformational structure and/or degrading the allergenic proteins in time frames relevant to common indoor air exchange rates.

9BA.10

Bioaerosols and Occupational Hygiene in Agricultural Industries. SHELLEY KIRYCHUK, Bernardo Predicala, Lifeng Zhang, James Dosman, Brooke Thompson, Alejandra Castillo Toro, Caroline Duchaine, *University of Saskatchewan*

Bioaerosols are common contaminants produced and emitted from agricultural production operations. Concentration, makeup, and risk related to bioaerosols is dependent on many factors including operation type (confined or open), animal concentration, management practices, manure handling practices, etc. Occupational hygiene for bioaerosol exposures related to livestock operations considers exposure levels, health outcomes for workers and for neighbors, and control measures for exposures.

Research in poultry and swine confinement operations has revealed that endotoxins are an important component of bioaerosols with relationships to health outcomes of exposed workers. Other components of bioaerosols such as beta glucans, gram positive bacteria, and antibiotic resistant genes are also present. The hierarchy of control, in relation to exposures, has been evaluated. The impacts of masks and other bioaerosol control measures such as oil sprinkling, on worker health outcomes, have been shown to impact dust and endotoxin levels and reduce health responses. Review of these findings and discussion of current and future research considerations are important to next steps.

9BA.11

Microbial Composition Comparison of Bioaerosol Samples with Two Co-located Bioaerosol Samplers: Condensation Growth Tube Collector and Electret Filters.

MARINA NIETO-CABALLERO, Claudia Mignani, Thomas C. J. Hill, Kristen Otto, Jessica Metcalf, Paul DeMott, Mark Hernandez, Sonia Kreidenweis, *Colorado State University*

Bioaerosol samplers are known to impart damage upon collection of bioaerosols. However, the bias in microbial community composition imparted by the different samplers remains unknown. For this reason, two samplers with significantly different sampling techniques (i.e., condensation growth tube collection or CGTC (BioSpot-VIVAS, Handix Scientific) and electret filtration (SASS3100, Research International)) were selected for microbial composition comparisons. Although alpha diversity metrics showed no significant differences between the samples collected with the two co-located samplers, microbial community composition (16S rRNA gene) was significantly different (p-value < 0.05) between the two collection methods. Despite differences in microbial community composition obtained by the two sampling methods, both captured changes in microbial community composition based on environmental factors (such as day and night sampling; p-value < 0.05). Here, we present results from these comparisons along with similar comparisons and findings from fungal data (ITS1 region). The findings of this study will help illuminate how instrumentation used in aerobiome studies can bias the reported results, usually due to microbial damage, and different collection efficiencies for sampler types for different bioaerosol size ranges, among others.

9BA.12

Studying Production of Respiratory Epithelial Aerosols and Droplets (SPREAD).

Jessica Resnick, TERRENCE GARCIA, Benjamin Alvarez, Natalie Sebeck, Michael Schuit, *JHU/APL*

Although the COVID-19 pandemic has receded, pathogen transmission by the aerosol route remains a serious and ongoing hazard. Because of this, there is a need for a capability to evaluate and quantify the aerosol transmission risk of existing and emerging pathogens, including rapid screening of novel variants, assessment of the potential for zoonotic spillover events, and evaluation of host and environmental factors that may affect the likelihood and timing of transmission or the effectiveness of interventions. Current methods used to predict transmissibility of novel pathogens are costly, use bulk cultured material, and often require the use of research animals.

We have developed a prototype method for generating aerosols directly from the apical surface of air-liquid interface (ALI) respiratory epithelial cell cultures, intended to mimic naturally occurring aerosol generation from breathing, coughing, and other respiratory maneuvers. Preliminary data suggest that it is feasible to generate aerosols from ALI cultures in sizes relevant to real-world respiratory particles while maintaining the viability and integrity of the cultures themselves. This method is being linked with a process to deposit aerosols onto the surfaces of ALI cultures to create a completely in vitro respiratory aerosol transmission cycle, reducing the need for animal studies and allowing manipulations of host and environmental variables to investigate transmission potential/ risk. This system is intended to be both broadly applicable (e.g. assessment of inter- and intra- species transmission) and able to be narrowly targeted (e.g. isolation of cells from individuals for a "personalized medicine" aerosol risk assessment).

This novel approach for studying respiratory aerosol transmission cycles has the potential to significantly accelerate the characterization of both emerging pathogens and novel variants of existing pathogens. This capability will enable crucial studies to aid in decision support and modeling as well as allow for quicker, near real-time threat characterization.

9BA.13

NATO Technical Activity: Sequencing for Environmental Aerosol Background Monitoring. Anna Anselmo, Markus Antwerpen, Maria Arevalo, Katharine Barr, Cory Bernhards, Radoslaw Bielawski, Anastasios Chanalaris, Matthew Clark, Marius Dybwad, Mats Forsman, Maria-Victoria Ortega-Garcia, Ulrich Gosewinkel, Ulrik Horn, Kamil Khanipov, SEAN KINAHAN, Lucas Krzowski, Richard Leggett, Claire Lonsdale, Ra'ad Mahmoud, James Marsay, Peter Rhodes, Shanna A. Ratnesar-Shumate, Abdoul Sare, Andreas Sjödin, et al., *DEVCOM Chemical and Biological Center*

Biological agents, including naturally occurring and modified pathogens pose a challenge to NATO operations as deployed forces may come in contact with endemic diseases, imported diseases, or even biological agents that are intentionally released by hostile actors. In addition, climate change is expected to accelerate the emergence or spread of zoonotic diseases, including those with pandemic potential.

Reliable and relatively fast methods for detection of harmful biological microorganisms in complex matrices are becoming more readily available both commercially and through S&T defense activities. Sequencing can be used to identify any biological threat, but first, the composition of the natural background, otherwise known as the metagenome, needs to be established. Biological aerosol backgrounds will vary based on location, season, time of day and meteorological conditions.

To this end, NATO has established a Research Task Group (RTG) to bring together sequencing and aerosol experts in the defense community to order to address challenges associated with environmental aerosol monitoring using sequencing-based approaches. They will focus on exploring and recommending best practices for sampling and collection methods; sample preparation; sequencing technology and establishing best use cases for each type of approach (short vs. long reads); analysis and interpretation of complex samples; recommendation on metrics and thresholds for improved user-confidence; and database requirements and management.

This presentation will summarize the RTG technical activity; identified key technical questions and issues to be addressed by the RTG; individual NATO participant activities and approaches to sequencing environmental backgrounds; and future ideas, concepts, and plans for the RTG effort.

9BA.14

Competition between Local and Distant Sources Determining the Concentration of Warm Temperature Ice Nucleating Particles in the Boundary Layer. Thomas C. J. Hill, SONIA KREIDENWEIS, Russell Perkins, Claudia Mignani, Leah Grant, Jessie Creamean, Paul DeMott, Carson Hume, Marina Nieto-Caballero, Kevin R. Barry, Noelle Bryan, Elizabeth Stone, Brian Heffernan, Teresa Feldman, Chamari Mampage, Janeshta Fernando, Drew Juergensen, *Colorado State University*

We still know relatively little about the relative contributions of local versus distant sources of ice nucleating particles (INPs) to the boundary layer. INPs active warmer than -20°C are of particular interest due to their relevance to mixed phase cloud glaciation and their predominantly organic/biological composition owing to their plant and/or soil sources. Here, we highlight results from several recent and complementary field campaigns that have shed light on factors that control the relative contributions of local versus distant sources of INPs. This included co-located measurements from the BioAerosols and Convective Storms (BACS) and Biology integration institute: Regional OneHealth Aerobiome Discovery Network (BROADN) campaigns in the northern Colorado plains, and measurements from Tracking Aerosol Convection Interactions ExpeRiment (TRACER) near Houston, Texas. During TRACER, the similarity of INP spectra at two sites 76 km apart indicated that INP concentration and composition was frequently dominated by regional transports. Similarly, results from a BROADN/BACS intensive suggest that exceptionally high concentrations of warm-temperature INPs (~1 L^{-1} at -10°C) resulted from emissions driven by thunderstorms in mesoscale convective systems 50-150 km upwind from the sampling site. In the absence of specific local disturbances (strong rain/hail, winds that raise soil dust, harvesting, plowing, fire) warm-temperature INPs will be an integration of regional sources.

9BA.15

Feasibility Study of BioTube: A Portable and Expandable Chamber for Passive Bioaerosol Sampling. JENNA MYERS, Gediminas Mainelis, *Rutgers, The State University of New Jersey*

Bioaerosols are suspended biological particles that include viruses, bacteria, mold, pollen, and their fragments and byproducts. Due to the adverse health effects they may trigger, active and passive sampling methods can determine bioaerosol presence and exposure in indoor and outdoor environments. Active sampling protocols are commonly utilized for bioaerosols due to their quantitative nature and relatively short sampling times, whereas passive samplers often have longer sampling times with less quantitative information. Previous studies examined the logistics of passive bioaerosol sampling with a settling chamber, also called a BioTube. Samples in this circumstance were collected onto agar plates confined within a nine-foot mailing tube via gravitational settling.

Due to the large dimensions of this settling chamber, the BioTube was redesigned. This study evaluated the practicality of a portable, collapsable BioTube in an outdoor environment and its collection effectiveness compared to an active sampler. Petri dishes filled with bacterial or fungal growth medium were placed inside five BioTubes adjacent to a one-stage Andersen cascade impactor to determine airborne bacterial and fungal concentrations. Each BioTube was hung upon deployment and then steadily expanded to pull ambient air in due to vacuum as the impactor ran simultaneously. Once the BioTube expanded to five feet in length, it was closed, and the captured microorganisms were allowed to settle overnight. Depending on the agar used, colonies grown on sampled plates were used to determine airborne concentration of culturable bacteria or mold. Average bacterial concentrations sampled by the BioTube and impactor were similar (265 CFU/m3 and 257 CFU/m3, respectively). In comparison, average fungal concentrations were more than two times greater in the impactor (6,209 CFU/m3) than in the BioTube (2,329 CFU/m3). Factoring in environmental conditions and convenience of use (e.g., no need for a pump), the collapsable BioTube shows promise as a low-impact bioaerosol sampling tool.

9BA.16

Changes in the Airborne Microbiome during High Density Public Gatherings: A Case Study of Mardi Gras in 2024. KAMIL KHANIPOV, Sarah Alnemrat, Vivian Tat, Kostiantyn Botnar, Sean Kinahan, Shanna A. Ratnesar-Shumate, Madison Farnsworth, Justin Nguyen, Matt Cochran, David Kimmel, Hema Narra, Christine Tomlinson, George Golovko, *The University of Texas Medical Branch*

Emerging and endemic infectious disease outbreaks continue to adversely affect our global health systems in spite of modern advances in medicine and healthcare. Therefore, characterization of bioaerosols is essential to mitigating and combating airborne disease outbreaks. This study focuses on the impact of high-density gatherings during Mardi Gras on the air microbiome in New Orleans, Louisiana. During the event, we collected high-volume air filters from several locations and time points, including key sites in New Orleans. Teflon (PTFE) air filters from environmental aerosol sample collectors were collected at over 100 liters per minute. DNA and RNA were isolated from the samples using the Zymo Biomics DNA/RNA miniprep kit. The RNA from the samples was converted to double-stranded cDNA using SuperScript IV VILO with ezDNase. DNA/RNA from the same samples were combined and prepared for sequencing on an Oxford Nanopore Technologies P2Solo instrument using the Ligation Sequencing Kit. PromethION R10.4.1 flow cells were utilized for sequencing. Sequencing data were basecalled using Dorado with the Super accurate model. The metagenome and metatranscriptome were analyzed using wf-metagenomics nextflow workflow.

Our results identified differences in the microbial composition of environments at various time points, establishing the background air microbiome. The data revealed significant shifts in microbial diversity and abundance during peak traffic periods of Mardi Gras, with a notable increase in human-associated bacterial taxa and environmental microbes. The resulting raw sequencing data, basecalls, sample metadata, and bioinformatic pipelines for environmental aerosol collectors are being compiled and shared to a public repository. Comprehensively defining the unique and evolving outdoor and indoor microbiome environments is vital to determining hazardous anomalies and disease outbreaks.

9CA.1

2-Methyltetrol Sulfate Oxidation by Hydroxyl Radical in Fog and Cloud Water Mimics and Its Implications for the Fate of Isoprene-Derived Secondary Organic Aerosol. HALEY ROYER, Ashley Harrill, Cade Christensen, Yuzhi Chen, Zhenfa Zhang, Avram Gold, Andrew Ault, Barbara Turpin, Jason Surratt, *University of North Carolina at Chapel Hill*

2-Methyltetrol sulfate diastereomers (2-MTS) are the single most-abundant SOA tracers in atmospheric fine particulate matter ($PM_{2.5}$). In isoprene-rich regions, multiphase IEPOX chemistry converts inorganic sulfate aerosol to organosulfates such as 2-MTS, making 2-MTS a major constituent of SOA mass. Though 2-MTS is pervasive within SOA, its fate in the atmosphere is still poorly understood. While recent studies have explored its sinks within deliquesced aerosol, 2-MTS has also been observed in cloud water, rainwater, hailstones, and snow, and its sinks within these atmospheric waters is unknown. In a series of controlled batch reactor experiments, we explore the oxidation of 2-MTS in fog and cloud water mimics to determine the second-order rate constant of 2-MTS oxidation against aqueous hydroxyl radicals (•OH). A decrease in 2-MTS concentrations and increase in reaction products were observed using hydrophilic interaction liquid chromatography interfaced to electrospray ionization high-resolution quadrupole time-of-flight mass spectrometry (HILIC/ESI-HR-QTFOMS). Samples were also analyzed using ion chromatography (IC) to corroborate mass spectrometry measurements of 2-MTS as well as to determine changes to inorganic sulfate concentrations. Results also include an estimated second-order rate constant for both cloud and fog water concentrations of 2-MTS and •OH. as well as proposed reaction products and reaction mechanisms for 2-MTS oxidation. These findings ultimately have implications for the composition, physical properties, and behavior of IEPOX-derived SOA.

9CA.2

Chemical Aging of Semivolatile Secondary Organic Aerosol Sesquiterpene Products. Christina N. Vasilakopoulou, Agata Błaziak, Damianos Pavlidis, Angeliki Matrali, Kalliopi Florou, Petro Uruci, SPYROS N. PANDIS, *University of Patras, Greece*

The oxidation of biogenic volatile organic compounds is an important pathway for the atmospheric formation of secondary organic aerosol (SOA). The contribution of sesquiterpenes to biogenic SOA remains uncertain, with field studies based on tracer compounds suggesting low values and some modeling studies suggesting that they can be more important than isoprene. Laboratory studies of sesquiterpene ozonolysis suggest high SOA yields, but the formed SOA has relatively low O:C and is inconsistent with biogenic SOA observations.

In an effort to explain these inconsistencies we follow a different approach. We perform atmospheric simulation chamber experiments starting from three first generation sesquiterpene ozonolysis products ($C_{10}H_{16}O_4$, $C_{13}H_{20}O_5$, $C_{15}H_{24}O_4$) and investigate their aging chemistry with the OH radical. The compounds were synthesized for the purposes of this work. The gas and particle phase composition was characterized with a high-resolution PTR-ToF-MS/CHARON system and an aerosol mass spectrometer (AMS) was also used.

The investigated sesquiterpene SOA components are semivolatile (C* of a few $\mu g\ m^{-3}$) based on our volatility measurements and the SOA within approximately one hour is oxidized to compounds with an average O:C approaching 0.7. The SOA AMS spectrum changes significantly as it ages. The functionalization reactions dominate over the fragmentation pathways and there is net increase in the SOA concentration. A physicochemical mechanism is proposed and tested for the description of the later generation gas-phase reactions converting the SOA to highly oxidized compounds. We estimate that around two thirds of the carbon follow the functionalization pathways. This suggests that quantification of the sesquiterpene SOA under ambient conditions based on the ozonolysis tracers can seriously underestimate its levels. Later generation products identified in this study can be more useful. The parameterizations developed in this work can be used in future modeling efforts to revisit the sesquiterpene contribution to SOA.

9CA.3

Impact of HOMs on Ambient Monoterpene SOA Formation in a German Forest. LAURENT POULAIN, Anke Mutzel, Yoshiteru Iinuma, Stefanie Richters, Dominik van Pinxteren, Martin Brüggemann, Andreas Held, Alfred Wiedensohler, Hartmut Herrmann, *Leibniz Institute for Tropospheric Research*

Secondary Organic Aerosols (SOA) result from the reactions of Volatile Organic Compounds (VOCs) emitted either from anthropogenic or biogenic sources. Although SOA represent an important fraction of the total organic aerosol mass, the models are up to now, mostly underestimating the ambient SOA concentrations. The SOA formation mechanism is a complex system where a large number of reactions and chemical species are involved. The complexity of the SOA formation leads to large uncertainties in its model prediction as well as in its potential climate impact. Over the last few years, the importance of highly oxygenated organic molecules (HOMs) in SOA formation has been demonstrated. However, there are still a lot of uncertainties regarding their contribution to the SOA mass. To better assess this question, an intensive Field campaign took place at the forest research station of the University of Bayreuth (Germany) in July 2014. A complementary set of real-time mass spectrometers including High-Resolution Time-of-Flight Aerosol Mass Spectrometer (HR-ToF-AMS), Chemical Ionization Atmospheric-Pressure interface Time-of-Flight Mass Spectrometer (CI-APiToF-MS) were deployed. To fully depict the chemical composition of the particles, offline chemical analysis based on a day-night regime of High-Volume quartz filter samples, was performed focused on Biogenic SOA tracers, as well as particulate HOMs tracers. The different sources of particles including several biogenic SOA factors as well as transport-related factors were identified from source apportionment analysis on combined AMS organic and inorganic mass spectra, supported by the offline analysis results. Combining these results with the gas and particulate HOMs results, allowed us a unique opportunity to investigate the relationship between HOMs and monoterpene SOA as well as new particle formation.

9CA.4

Chemical Characterisation of Total Organic Carbon in PM10 Aerosols during a Festive Firework Event Using 1H NMR in Mumbai, India. SHWETA SAKPAL, Avik Kumar Sam, Shreya Dubey, Harish C Phuleria, *Indian Institute of Technology, Bombay*

Background:
Diwali, celebrated worldwide, can be considered significant among many episodic events involving the substantial burning of fireworks associated with decreased air quality.

Objectives:
The present study aims to chemically characterize the total organic carbon in PM_{10} during Diwali using proton Nuclear Magnetic Resonance (^{1}H NMR).

Materials and Methods:
PM_{10} aerosols were collected throughout the day in four periods (each 6h): morning, afternoon, evening, and night at an urban background location for two days: a day before and on the day of Diwali, in October 2022. The filters were extracted in water and methanol, followed by ultrasonication. The methanol-extracted filters were freeze-dried and redissolved in 0.03% w/v DSS-CD_3OD for ^{1}H NMR, while the water-extracted were subjected to TOC Analyser for Water-Soluble Organic Carbon (WSOC).

Results and Discussion:
High PM_{10} was observed throughout the sampling (2593.7±137.3 μg/m^3), with the maximum reported on Diwali night (2858.1 μg/m^3), while the WSOC was 232.26% higher than the non-Diwali night. The NMR analysis indicates that aliphatic groups (6072.9±1126.4 μmol/m^3) are the dominant groups, followed by unsaturated structures (2947.1±653.8 μmol/m^3) and the oxygenated groups (2294.2±305.5 μmol/m^3), while the aromatic structures contributed the lowest resonances (362.1±97.4 μmol/m^3). Diurnally, there was a decrease in concentrations from morning to afternoon, followed by an increase during the evening. Traffic activities are higher in the background during the morning, while the evening witnessed significant burning of firecrackers. On Diwali night, there were 51.1%, 185.1% and 170.3% increases in aliphatics, unsaturated and oxygenated groups compared to the previous night, while the aromatic structures decreased by 49.7%. In contrast, the aliphatics and aromatics on Diwali evening increased by 439.6% and 654.5% to the previous day. Our study highlighted the significant contribution of firecrackers towards the poor air quality observed while further analysis is underway.

9CA.5

AE36 Aethalometer: Performance Demonstration and Application of Black Carbon Index. MARTIN RIGLER, Matic Ivančič, Bálint Alföldy, Irena Ježek Brecelj, Asta Gregorič, *Aerosol d.o.o.*

The recommended guidelines for particulate matter (PM2.5 and PM10) issued by the World Health Organization (WHO, 2021) have been reflected in the updated directives of the Environmental Protection Agency (EPA) in the United States and the European Union. Specifically, the annual mean concentration for PM2.5 has been reduced to 9 µg/m³ in the United States and 10 µg/m³ in the European Union. Under the extant standards in Europe, less than 1% of the population is exposed to air with PM2.5 concentrations exceeding the prescribed limits. However, this proportion escalates to 97% when evaluated against the WHO guidelines. To be able to further decrease PM2.5 concentrations, mitigation strategies must be targeted to specific sources, and source apportionment needs to be implemented in monitoring networks. Carbonaceous aerosols (CA) contribute significantly to the PM2.5 mass concentration. Additionally, black carbon (BC), in particular, which is highlighted as a good practice statement in 2021 WHO guidelines, has been associated with a range of adverse health effects, including respiratory and cardiovascular diseases, cancer, and even birth defects.

The Aethalometer is a widely used filter photometer capable of measuring the light-absorbing properties of aerosol particles, especially BC. In this study, we present the performance of the new Aethalometer model AE36 (Aerosol Magee Scientific), developed to meet the needs of the monitoring community. The performance of new Aethalometer has been significantly enhanced by redesigning the filter compartment, which is now robust to changes in relative humidity (RH). The AE36 is designed for long-term unattended operation, facilitated by a new self-cleaning procedure and a 20m filter tape. The communication of pollution levels to the public has been simplified with the implementation of a Black Carbon (BC) index, which is a proprietary measure of air quality based on Black Carbon concentrations. BC index follows the principle of Air Quality Index determination. It relies on the linear interpolation method of BC concentration applied between pre-set boundaries of BC index categories (Fung et al., 2022):

$$\text{BC index}=(I_{high}-I_{low})/(BC_{24,high}-BC_{24,low})\bullet(BC_{24}-BC_{24,low})+I_{low},$$

where BC_{24} is the 24 hour running mean of hourly averaged BC concentration, $BC_{24,low}$ and $BC_{24,high}$ are the lower and upper limit of the index category, and I_{low}, I_{high} are the corresponding index values. The performance of AE36 with improvements mentioned above was evaluated and compared to its predecessor AE33 during a long-term field campaigns at an urban background and remote sites. 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.

9CA.6

Interlaboratory Comparison of the Centrifugal Particle Mass Analyzer-Electrometer Reference Mass System (CERMS). RYM MEHRI, Robert T. Nishida, Timothy Sipkens, Jason S. Olfert, Joel Corbin, Gregory Smallwood, *National Research Council Canada*

CERMS is a combination of instruments capable of producing an aerosol of a known mass concentration, independent of particle properties. It consists of (1) a unipolar diffusion aerosol charger (UDAC) that uses a corona discharge to charge the particles; (2) a centrifugal particle mass analyzer (CPMA) to classify the particles based on their mass-to-charge ratio; and (3) an aerosol electrometer to measure the charge concentration. This system has the proven ability to calibrate nonvolatile particulate matter (nvPM) mass concentration instruments, including those measuring equivalent black carbon, refractory black carbon, or total carbon via thermal-optical analysis (TOA). CERMS shows repeatability and intermediate precision of approximately 1% and 2%, respectively, when tested in laboratory settings, however reproducibility has not been investigated. TOA has been associated with large uncertainty (k=2) for elemental carbon mass concentration (17-20%).

This work seeks to robustly define the uncertainty associated with CERMS measurements and aims to quantify the reproducibility of this system in different settings using different sources. For this purpose, an interlaboratory comparison of CERMS systems from three independent laboratories was conducted in two parts. First, a laboratory comparison was conducted using a miniature inverted soot generator (MISG) for the particle source to provide initial demonstration of the study feasibility. Second, the same procedure was applied to assess CERMS reproducibility during a campaign using a Start Cart and J85 gas-turbine engine as particle sources.

For both components of the interlaboratory comparison, results show high repeatability (k=2) for the electrometer (0.9-1.3%) and CPMA (1.6-2.3%) compared to CERMS repeatability (k=2) (6.3-11.2%). The reproducibility (k=2) of CERMS ranged from 6.3 to 15.4%.

9CA.7

Using an Unmanned Aerial Vehicle to Sample Aerosols in Wildfire Plumes. JOHN RYAN HIMES, Christian Carrico, Manvendra Dubey, Jon Reisner, *New Mexico Institute of Mining and Technology*

The low-intensity ground-level fires necessary for forest health have increasingly been replaced by uncontrolled, crowning, and stand-replacing fires due to a warming climate and accumulated fuel loads. This not only has led to a substantial loss of land and livelihoods, but has also raised serious air quality concerns. Wildland fires emit significant amounts of particulate matter less than 2.5 micrometers in aerodynamic diameter ($PM_{2.5}$) including black carbon (BC) and brown carbon (BrC) particles. The inhalation of $PM_{2.5}$ has been known to cause numerous adverse health effects while BC and BrC hold their own climate-forcing potential and remain large uncertainties in climate models. Traditional ground-based air quality measurements are prone to missing a wildfire plume depending on wind direction and plume loft. Using a customizable unmanned aerial vehicle (UAV) to carry lightweight instrumentation provides a means to actively sample a wildfire plume and provide critical data for climate model validation. Two instrument types were utilized in initial UAV flights: a multiwavelength light absorption instrument (AethLabs MA200) and a light-scattering based mass concentration sensor (PurpleAir). Due to its recent inception, laboratory experiments were conducted to validate the PurpleAir. By aerosolizing liquid smoke, a good optical proxy for BrC, two Purple Air sensors were found to be well correlated to two QuantAQ modules ($R^2 > 0.98$) and showed slope values of 0.8 to 1.2. Initial UAV flights were conducted at the Socorro Fire Training Center (SFTC) to sample emissions from burning buildings and diesel fuel spills; both of which are representative of fuels in the wildland-urban interface. The UAV system was able to detect distinct BC and BrC dominated regimes and transitions (determined by calculating the Absorption Ångström Exponent) as well as map gradients in $PM_{2.5}$ concentrations from background to extremely high concentrations ($>1300 \mu g/m^3$).

9CA.8

Emission Inventories Underestimate Black Carbon in the Global South as Revealed by Comparison of Simulations with Measurements from a Globally Distributed Network. YUXUAN REN, Randall Martin, Christopher Oxford, Dandan Zhang, Xuan Liu, Ann M. Dillner, Rajan K. Chakrabarty, Sina Hasheminassab, David Diner, Joshin Kumar, Valerie Viteri, *Washington University in St. Louis*

Characterization of black carbon (BC) on a global scale is essential for understanding its impact on climate forcing and human health. However, high uncertainty persists in global BC simulations and inventories. Here, we evaluate BC simulations for the year 2019 from a global chemical transport model (GEOS-Chem) in its high-performance configuration using the Community Emissions Data System (CEDS) emission inventory versus measurements from the globally distributed Surface Particulate Matter Network (SPARTAN) and other available measurements. Results indicate a high degree of consistency ($r^2 = 0.81$; slope = 1.26) of the simulation with SPARTAN measurements across primarily developed countries in northern midlatitudes and Australia, but pronounced discrepancy across the Global South ($r^2 = 0.19$, slope= -0.52). Notably, Africa and South Asia exhibit substantial underestimations, with average simulated-to-observed ratios of 0.11 in Dhaka, Bangladesh, 0.15 in Addis Ababa, Ethiopia, and 0.26 in Ilorin, Nigeria. The discrepancy between simulations and observations is primarily attributed to limitations in existing emission inventories, and using alternative inventories including the EDGAR and HTAP within the model yields similar results. These findings motivate renewed attention to the challenging tasks of characterizing BC emissions from developing countries.

9CA.9

Capillary Condensation as an Unaccounted Pathway for Rapid Aging of Atmospheric Soot. ELLA IVANOVA, Egor Demidov, Nicole Riemer, Gennady Gor, Alexei Khalizov, *New Jersey Institute of Technology*

Combustion soot is not only an air pollutant but also a powerful climate warming agent because its high light absorptivity across a broad range of solar spectrum results in significant direct climate impact. Soot is hydrophobic initially, and hence, its indirect climate impact is insignificant at the time of emission. Experiments show that the fractal morphology of soot particles promotes rapid condensation of subsaturated vapors, such as water-soluble trace chemicals, changing the hydrophobic nature of soot, and allowing water absorption and particle compaction at moderate humidity levels. This transformation has the potential to transform initially hydrophobic soot particles into cloud condensation nuclei (CCN). However, current atmospheric models do not take into account the fractal morphology of soot particles, treating them as spheres and thereby omitting the process of soot aging by capillary condensation of subsaturated chemicals.

Recently, we developed a capillary condensation model for fractal soot aggregates and tested it against laboratory experiments. In this study, we integrate this capillary condensation model with the atmospheric aerosol model PartMC-MOSAIC to evaluate the role of subsaturated trace chemicals in atmospheric soot processing. To see the effect of capillary condensation clearly, we selected an atmospheric scenario corresponding to subsaturated conditions of condensable vapors, typical of atmospheric conditions dominated by biogenic emissions, and with low anthropogenic emissions of such chemicals as sulfur dioxide. A biogenic scenario representing the Duke Forest area (North Carolina) was configured and the compositions of the gas and aerosol species were predicted using PartMC-MOSAIC. In the next step, the capillary condensation model was applied to evaluate the supersaturations of condensable chemicals and predict their condensation on fractal soot. The hygroscopic kappa theory was used to predict the evolution of the critical supersaturation of water with soot aging. The results show that fractal soot can undergo a rapid transformation (2-3 hours) from hydrophobic to hydrophilic state, significantly faster than if the soot particles were represented as spheres. Thus, the previously overlooked mechanism of capillary condensation on fractal particles can lead to the rapid aging of atmospheric soot, which needs to be incorporated into aerosol models.

9CA.10

Discrete Element Method Model for Restructuring of Soot Aggregates. EGOR DEMIDOV, Gennady Gor, Alexei Khalizov, *New Jersey Institute of Technology*

Soot is a major component of atmospheric aerosols and it affects climate primarily by scattering and absorbing the sunlight. Morphologically, soot particles are fractal aggregates made of elemental carbon. In the atmosphere, the aggregates acquire coatings by interacting with trace gas chemicals and water vapor, resulting in significant compaction of the aggregates. The addition of coatings and morphological compaction lead to changes in light absorption and scattering, and hence in direct climate forcing by soot aerosol. The mechanism of soot restructuring is not yet fully understood and no models exist to rigorously describe the process of restructuring. Hence, the fractal morphology of soot and its evolution are neglected in atmospheric models, leading to reduced prediction accuracy. To address this deficiency, we develop a discrete element method model to quantitatively simulate restructuring of fractal soot aggregates. In the model, the aggregate is represented as a collection of spheres joined by cohesion and by covalent necks. To describe forces acting in an aggregate, we combine in an open-source code models for elastic bonds, non-bonded frictional contacts, and van der Waals attraction between spheres in the aggregate. The developed model is parametrized based on atomic force microscopy (AFM) force-displacement curves, recorded for soot aggregates unraveled by the AFM cantilever tip. Future work involves adding to the model capillary forces produced by atmospheric condensates and integrating the soot restructuring model into a large-scale atmospheric simulation to quantify the time scale and extent of restructuring occurring under natural conditions.

9CA.11

Influence of Hydrogen Content on the Optical Properties of Carbonaceous Aerosols: Insights from Atomic Scale Simulations. JOSHIN KUMAR, Gwan-Yeong Jung, Rohan Mishra, Taveen Kapoor, Rajan K. Chakrabarty, *Washington University in St. Louis*

The role of carbonaceous aerosols in climate models is critically influenced by their optical properties, contributing significantly to uncertainties in global radiative forcing predictions. Recent studies have utilized particle-scale modeling and experimental approaches to examine the optical characteristics within the black-brown continuum of these aerosols. However, there remains a substantial gap in understanding how atomic-scale structures of these carbonaceous particles and their electronic properties correlate with these optical behaviors. This study aims to bridge this gap by exploring the relationship between the atomic structure, hybridization, and bulk optical properties of carbonaceous aerosols through atomic-scale simulations using Density Functional Theory (DFT).

Utilizing molecular dynamics and DFT, we first constructed atomic models of pristine black carbon and subsequently doped these structures with varying concentrations of hydrogen, within experimentally validated composition ranges. For each configuration, we then computed the structural, electronic, and optical properties including pair correlation function, average hybridization of carbon atoms, density of states, and complex refractive indexes.

Starting with amorphous black carbon structures, increasing hydrogen concentration leads to a higher proportion of sp3 hybridization and a corresponding decrease in the imaginary (absorbing) refractive index. Increasing hydrogen concentration simulated progressively browner particles indicating shift from black to brown part of the absorption continuum that align with Saleh et al. (2020). Notably, an increase in hydrogen content also results in changes to the short-range pair correlation function, primarily due to enhanced C-H bonding, while maintaining the amorphous nature at longer ranges.

These findings provide a foundational understanding of how variations in hydrogen concentration impact the structural, electronic, and optical properties of carbonaceous aerosols at an atomic level. This study underscores the potential of first-principles simulations in predicting and tuning aerosol impacts on climate modelling.

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

9CA.12

Particle Light Absorption Closure Analysis: BC, Soluble BrC and Dark-BrC: Case Studies from FIREX-AQ and AEROMMA. RUCHEN ZHU, Linghan Zeng, Han N. Huynh, Adam Ahern, Joshua P. Schwarz, Amy P. Sullivan, Rodney J. Weber, *Georgia Institute of Technology*

Atmospheric aerosols directly affect the radiative balance of the atmosphere, visibility, and photochemical reactions by absorbing and scattering solar radiation. Carbonaceous species, largely from biomass burning, are a major component of light-absorbing aerosols. Light absorbing carbon can be divided into three categories - black carbon (BC), soluble brown carbon (BrC) and dark brown carbon (d-BrC, or tar BrC, or tar balls) which are thought to be mutually exclusive. Increasing prevalence of wildland and prescribed fires makes understanding the optical properties of their emissions important. We perform a closure analysis by comparing the measurement of total absorption using a three-wavelength photoacoustic spectrometer (PAS) to the sum of the various light absorbing components, including refractory BC with estimated lensing, soluble BrC and d-BrC. We use data from the extensive suite of wildfire smoke characterized during FIREX-AQ and aged smoke measured in AEROMMA. Various parameters needed to predict optical properties of the components are based on published values. We find that at high wavelengths, there is a gap between the sum of rBC and soluble BrC and the PAS and attribute this to d-BrC. We predict the characteristics of d-BrC to fill this gap and find d-BrC mass concentration is the most important parameter. We attempt to find parameters related to the smoke that can account for this variability in d-BrC concentration. At low wavelengths, we find the sum of the absorbing components exceeds the total absorption measured with the PAS and look for parameters that may be linked to the magnitude of the over-estimation to provide a physical explanation for its cause. The goal of this work is to provide a better understanding of the components contributing to aerosol light absorption in wildfire smoke.

9CA.13

Evolution of Black Carbon upon Coating with Biomass Burning Organic Aerosol. CHRISTIAN ESCRITT, Katrina Betz, Micah Miles, Elijah Schnitzler, *Oklahoma State University*

As the instances of severe wildfire increase across much of the US, the interactions between emissions of biomass burning and urban sources at the wildland-urban interface become more critical to air quality and climate change. In the urban environment, uncoated aggregates of black carbon (BC) are commonly emitted from diesel engines used in transportation. When biomass burning emissions are transported across the wildland-urban interface, these BC aggregates are exposed to biomass burning organic aerosol (BBOA), composed of many compounds with wide ranges of chemical, physical, and optical properties, including volatility. The components of BBOA will partition onto the BC aggregates, and the resulting coatings will cause changes to the morphology and hygroscopicity of BC, which impact its interactions with radiation and clouds. Here, we investigate the effects of different volatility fractions of BBOA, representative of different ages of plumes with respect to dilution in the atmosphere, on BC restructuring. From timeseries of diameter growth factors for coated and coated-denuded BC particles, we determine that, as volatility decreases, more coating is necessary for the same amount of restructuring. We will discuss the results and their implications in the context of previous studies of BC restructuring. Broadly, our observations indicate that fresh wildfire plumes may have more potential to impact the morphology of BC at the wildland-urban interface.

9CA.15

Predictive Analytics of Black Carbon in High-Concentration Region Using Machine Learning Models. PRATIMA GUPTA, Pau Ferrer-Cid, Jose M. Barcelo-Ordinasb, Jorge Garcia-Vidal, Mar Viana, Mira L. Pöhlker, Ajit Ahlawat, *Indian Institute of Technology Delhi*

Black carbon (BC) is emitted into the atmosphere during combustion processes, often in conjunction with emissions such as NOx and O3, which are also by-products of combustion. In highly polluted regions, combustion processes are one of the main sources of aerosols and particulate matter (PM) concentrations, which affect the radiative budget. In this study we use machine learning approaches to estimate BC from NOx, O3, PM2.5, relative humidity (RH), and solar radiation (SR). We assess the effectiveness of various machine learning models, such as random forest (RF), support vector regression (SVR), and multilayer perceptron (MLP) artificial neural network, for predicting black carbon (BC) mass concentrations in areas with high BC levels such as Northern Indian cities (Delhi and Agra), across different seasons. This study evaluates the performance of models in Delhi using data from 2018-19, including NOx, O3, PM2.5, relative humidity (RH), and solar radiation as input variables and Agra. The results demonstrate comparable effectiveness among the models, with the multilayer perceptron (MLP) showing the most promising results. In Delhi, the MLP shows high correlations between measured and modelled concentrations during winter (R2: 0.85) and post-monsoon (R2: 0.83) seasons, and notable metrics in the pre-monsoon (R2: 0.72). The results from Agra are consistent with those from Delhi, highlighting the consistency of the neural network's performance. These results highlight the usefulness of machine learning, particularly MLP, as a valuable tool for predicting BC concentrations. This approach provides critical new opportunities for urban air quality management and mitigation strategies and may be especially valuable for megacities in medium- and low-income regions.

9CA.16

Evaluation of U.S. Residential Wood Burning Emission Estimates and Air Quality Modeling during the 2015 WINTER Campaign.

BENJAMIN MURPHY, Havala Pye, Karl Seltzer, Amara Holder, Joseph Martin, Ingrid George, Gabriel Isaacman-VanWertz, Amy P. Sullivan, Pedro Campuzano-Jost, Jose-Luis Jimenez, Madeleine Strum, *U.S. 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 Emissions Inventory estimates. The impact of these emissions on air quality is substantial, especially in the wintertime when wood is used for heating. However, existing inventories and air quality models typically use outdated emission factors and simplified chemical mechanisms to describe the sources and chemistry of organic particles and vapors. State-of-science analyses of emissions data may use gas/particle partitioning theory and detailed speciation measurements to interpret operationally defined emission factor measurements and connect them to rigorous chemical mechanisms designed to conserve reactive organic carbon (ROC) in multiple phases.

This presentation focuses on the evaluation of new multiphase ROC emission factors and speciation profiles derived from US EPA measurements and existing literature. These inputs drive simulations with the Community Multiscale Air Quality (CMAQ) model employing the new Community Regional Atmospheric Chemistry Multiphase Mechanism (CRACMM). Model results are evaluated with ground and aircraft measurements made during the Wintertime INvestigation of Transport, Emissions, and Reactivity (WINTER) 2015 campaign over the Eastern United States. Levoglucosan measurements and organic particle source attribution analyses are consistent with CMAQ predictions using the new emission data. The study emphasizes the value of such measurements for constraining residential wood burning impacts in areas across the northern U.S. outside the WINTER domain.

9CA.17

Light-absorption Properties of Secondary Organic Aerosol Emitted from Duff Burning.

MUHAMMAD ABDURRAHMAN, Rawad Saleh, *University of Georgia*

Previous studies have shown that secondary organic aerosol (SOA) that forms from the photochemical aging of biomass-burning emissions is light-absorbing and falls under the umbrella of brown carbon (BrC). However, retrieving the imaginary part of the refractive index of biomass-burning SOA (k_{SOA}) is not straightforward. k_{SOA} has previously been inferred from optical measurements of the aged aerosol, which is comprised of SOA and primary organic aerosol (POA).

This study presents direct quantification of the light-absorption properties of SOA derived from duff burning. We performed smoldering combustion of duff in an environmental chamber and photochemically aged the emissions in an oxidation flow reactor (OFR) under two configurations: (1) sending all the emissions (particles and vapors) into the OFR and (2) first filtering out the particles and sending only the vapors into the OFR to isolate the SOA. Mass concentrations, obtained from integrating size distributions measured using scanning mobility particle sizer, of the fresh and aged aerosol showed significant organic aerosol enhancement (SOA/POA = 0.82 ± 0.18). We performed optical closure, which involved fitting Mie theory calculations to absorption coefficients measured using a photoacoustic spectrometer, to retrieve k at 422 nm of POA ($k_{POA,422} = 0.0184 \pm 0.0007$), aged aerosol ($k_{aged,422} = 0.0114 \pm 0.001$), and SOA ($k_{SOA,422} = 0.0094 \pm 0.0009$).

These results confirm that biomass-burning SOA is light-absorbing, though to a lesser extent than POA. Furthermore, inferring the light-absorption properties of SOA from the aged aerosol measurements (assuming that the aged aerosol absorption is a combination of that of the POA and SOA) yields $k_{SOA,422} = 0.0028 \pm 0.0015$, more than a factor of 3 smaller than $k_{SOA,422}$ retrieved from direct SOA measurements. This discrepancy suggests that photochemical aging of POA leads to reduction in absorption due to photobleaching, as has been reported by previous studies.

9CA.18

Formation of Aqueous SOA from Water-Soluble Gaseous α-Pinene Oxidation Products and from Gases Emitted by Biomass Burning Emissions. MATT ZARAGOZA, Sergey Nizkorodov, Annmarie Carlton, *University of California, Irvine*

Aqueous secondary organic aerosol (aqSOA) refers to compounds that are produced by aqueous oxidation of small organic molecules in cloud and fog water. A number of experiments on the formation of aqSOA from individual compounds (such as phenols, glyoxal, methyl glyoxal, pyruvic acid, etc.) have been done in the past. However, aqueous droplets contain complex mixtures of water-soluble organic gases, and it is important to study aqSOA formation from environmentally relevant mixtures. The goal of this work is to study the formation of aqSOA from water-soluble gaseous α-pinene oxidation products and from gases emitted by biomass burning emissions. Gaseous α-pinene oxidation products were generated in an oxidation flow reactor using OH as the primary oxidant. Ozone was photolyzed in the presence of water vapor to produce OH radicals, which initiated the oxidation of α-pinene. The oxidation products were passed through a Teflon 0.2 um filter to remove particulate compounds. A mist chamber was used to scrub the remaining gaseous products into an aqueous solution to separate water-soluble components from insoluble components. Photooxidation experiments were then performed by adding hydrogen peroxide to the solution and exposing the solution to 254 nm radiation to simulate secondary cloud-processing across various time intervals. Mass spectrometry was used to observe products of aqueous photooxidation. The volatility of the observed products was predicted from their molecular formulas to assess whether these products have low enough volatility to contribute to aqSOA. The experiments are currently ongoing, and the first results should be available by the time of the AAAR meeting.

9CC.1

Secondary Aerosol Formation Potential and Transportation of Air Pollution off the Coast of Southern California. MINGHAO HAN, Bradley Ries, Dongli Wang, Alexander B. MacDonald, Roya Bahreini, Andrew Metcalf, Don Collins, *University of California, Riverside*

The California Bight region of the Pacific Ocean, extending from Point Conception in California to Punta Colonet in Baja California, Mexico, is characterized by its consistent and expansive stratocumulus cloud coverage. Airborne pollutants from the Los Angeles/Long Beach (LA/LB) area can be transported offshore, where they interact with this cloud layer and are also transported southward towards the San Diego area by prevailing winds. This geographic setting is particularly conducive to the study of aerosol-cloud interactions (ACI) involving marine stratocumulus clouds and a diverse mix of pollution-derived and natural aerosols. During the Eastern Pacific Cloud Aerosol Precipitation Experiment (EPCAPE) campaign, which took place in La Jolla, CA, the Naval Postgraduate School Twin Otter aircraft was utilized for an intensive 4-week, 90-flight-hour campaign off the Southern California coast in June 2023. These flights were aimed at providing a regional perspective for the EPCAPE measurements and included comprehensive below-cloud, in-cloud, and above-cloud data collection across a range of meteorological and aerosol conditions. As part of the Southern California Interactions of Low Cloud and Land Aerosol (SCILLA) experiment, the project team operated an array of instruments on the aircraft, including an Oxidation Flow Reactor (OFR) system specifically designed for airborne measurements, a Cloud Condensation Nuclei Counter, an mini Aerosol Mass Spectrometer (mAMS), and various trace gas analyzers. Here we focus on the secondary aerosol formation potential in air affected by emissions from LA/LB, as well as by atmospheric gas and cloud processing over the Bight. This study explores transformation processes, spatial distribution, and the SOA formation contribution of pollution off the coast of Southern California.

9CC.2

The Effects of Organic Solvents on the Water Uptake of Organic Aerosols. Kotiba A. Malek, Nahin Ferdousi, Dewansh Rastogi, AKUA ASA-AWUKU, *University of Maryland, College Park*

Organic solvents are atmospherically ubiquitous, yet their effects on cloud droplet formation have been poorly investigated. To elucidate on the effects of solvents on cloud formation, this work investigated the water uptake efficiencies of aerosols obtained from three organic isomers of different solubility namely, Phthalic acid (PTA), Isophthalic acid (IPTA), and Terephthalic acid (TPTA) in the presence of aqueous-phase and gas-phase ethanol (EtOH). The water uptake properties were investigated under supersaturated and subsaturated conditions using a Cloud Condensation Nuclei Counter (CCNC) and a Hygroscopicity Tandem Differential Mobility Analyzer (H-TDMA), respectively. Under supersaturated environment, the presence of EtOH was shown to increase water uptake efficiency of partial and low solubility particles: IPTA and TPTA but not the water-soluble PTA particles. The intrinsic solubility of the aerosol particle governs its water uptake behavior in supersaturated conditions. Hence, since PTA exhibits a high-water solubility, the presence of EtOH exerted little to no influence on the dissolution of PTA particles. Conversely, the addition of EtOH to IPTA and TPTA aerosols enhanced the dissolution of these partial/low-water solubility particles; as a result, increasing their water uptake affinity. Our subsaturated results show that EtOH has the opposite effect relative to our supersaturated results. Under subsaturated environment, the water uptake affinity of PTA particles was enhanced by the presence of EtOH and diminished for IPTA and TPTA particles. This is attributed to the morphological properties of particles supported by TEM images and shape factor measurements. Hence, atmospheric organic solvents can readily coat aerosol particles and play a major role in the water uptake properties under sub- and supersaturated conditions.

9CC.3

An Initial Assessment of the Viscosity and Phase State of Wildfire Smoke Particles in the Stratosphere. Allan K. Bertram, MEI FEI ZENG, Andreas Zuend, Daniel Murphy, Gregory Schill, *University of British Columbia*

Large wildfires periodically eject massive amounts of biomass burning organic aerosol (BBOA) into the stratosphere, where it can linger for many months and catalyze ozone-destroying reactions. To predict this multiphase chemistry, information is needed on the viscosity and phase state of BBOA. In the following, we used laboratory data and a thermodynamic model to assess the viscosity and phase state of BBOA in the stratosphere. Results suggest that the unaged BBOA and BBOA aged 1.5 days by hydroxyl radicals are in a glassy state for a wide range of temperatures in the stratosphere (approximately 200-275 K). After long-term aging (weeks to months) and H_2SO_4 uptake (25 wt % H_2SO_4), the particles may still be in a glassy state or more viscous than tar pitch (10^8 Pa s) between approximately 205-245 K in the stratosphere. These high viscosities could shut off bulk reactions within BBOA particles, and the glassy state could nucleate crystalline polar stratospheric clouds, which can amplify stratospheric ozone depletion. If the H_2SO_4 content reaches 50 %, BBOA likely do not form a glassy state for the full range of temperatures in the stratosphere. However, the viscosities could still reach as high as 10^6-10^{10} Pa s for some conditions in the stratosphere, which could influence multiphase reaction rates within BBOA. Additional studies are needed to confirm the predictions presented here.

9CC.4

Vertical Profile of the Chemical Composition and Mixing State of Summertime Ambient Aerosols in the Southern Great Plains.

XENA MANSOURA, Zezhen Cheng, Gregory W. Vandergrift, Nurun Nahar Lata, Valentina Sola, Zhenli Lai, Ashfiqur Rahman, Jeffery Dhas, Zihua Zhu, Damao Zhang, Fan Mei, Swarup China, *Pacific Northwest National Laboratory*

Ambient aerosols in the US Southern Great Plains (SGP) were collected on June 19th, 2023, utilizing the Atmospheric Radiation Measurement (ARM) U.S. Department of Energy (DOE) unmanned aerial system (UAS) Arctic Shark. The UAS-ArcticShark took flight at 14:41 UTC and sampled ambient aerosols at six altitudes starting with position two (p2) at 1829m (AMSL), p3 at 1676m, p4 at 1372m, p5 at 1067m, p6 at 762m, and p7 at 610m. Samples were also collected for all altitudes (600-2000m) at the beginning and end of the flight (position 1 and position 8). The Size and Time-resolved Aerosol Collector (STAC) impactor system was used to collect these aerosol samples in the lower troposphere.

In-situ measurements collected particle size and concentration data, as well as relevant meteorological information such as relative humidity and temperature. Size, time, and altitude resolved-ambient aerosols in the SGP were analyzed offline by Scanning Electron Microscopy with Energy Dispersive X-Ray Spectroscopy (SEM/EDX) and Scanning transmission X-ray microscopy coupled with near-edge X-ray absorption and fine structure (STXM-NEXAFS) spectroscopy to probe their size, morphology, mixing state, and chemical composition. Further, nanospray desorption electrospray ionization (nanoDESI-HRMS) high resolution mass spectrometry analysis techniques was used to probe organic molecular formula.

In addition, we leveraged ARM ground lidar measurements to understand the heterogeneity of air masses. The lidar measurements presented an elevated aerosol layer around 2000m AMSL and a well-mixed boundary layer below 1100m AMSL. Based on this information, we classified our samples into two cases: case study 1 as high-altitude cloud influenced samples (p2-p4), and case study 2 as boundary layer influenced (p5-p7). The case 1 samples were transported from higher altitudes based on the back trajectory simulations and their compositions show carbonaceous sulfate particles dominating in larger size ranges (>0.5 µm), suggesting cloud influence. Case study 2 samples show an increase in the size mode with decreasing altitude, suggesting that possible new particle formation events may be occurring at these layers. The HRMS data shows case study 1 with a higher number fraction of nitrates and sulfate groups, further supporting that these layers may have been cloud influenced. Case study 2 shows changes in volatility suggesting that these samples may have been influenced by the boundary layer. The two layers seem to have been influenced by distinct airmasses—case study 1 from the clouds and case study 2 from the boundary layer.

9CC.5

The Role of Supersaturation in Tropical Atlantic Marine Boundary Layer Aerosol-cloud Observations.

JERAMY DEDRICK, Christian Pelayo, Lynn M. Russell, Dan Lubin, Mark Miller, Johannes Mülmenstädt, *Scripps Institution of Oceanography*

Low-level cloud microphysical properties are very sensitive to changes in the properties of aerosol, particularly in clean marine regions where small relative number concentration changes are amplified in low baseline conditions. In this work, we evaluated the Twomey effect using aerosol, cloud, and radiative observations below low-level marine clouds on a remote tropical South Atlantic island during the DOE ARM Layered Atlantic Smoke Interactions with Clouds (LASIC) campaign. Measured aerosol size distributions were fit with three modes representing Aitken, accumulation, and sea spray aerosol and combined with submicron composition to estimate hygroscopicity. To investigate cloud supersaturation (S), we retrieved the Hoppel minimum diameter from modal fits and hygroscopicity estimated from submicron composition. Accumulation-mode aerosol contributed 75% of the cloud condensation nuclei (CCN) number at S<0.3%. Three ensemble-based and two parcel-based approaches were employed to further estimate S using measured aerosol and droplet concentrations and local cloud base updrafts across clean and smoky conditions. S agreed well with a parameterization constrained by the observed accumulation-mode aerosol and updraft, but not for the quasi-steady state approximation. Increases in accumulation-mode number increased cloud drop number, showing the activation response to aerosol, and reduced supersaturation most strongly at low updraft, illustrating the supersaturation response to aerosol. Droplet size sensitivities to aerosol number were included in a modified decomposition of the cloud albedo susceptibility into Twomey and meteorological components. These results show a strong sensitivity of the LASIC cloud baseline to aerosol perturbations.

9CC.6

Vertical Transport of Ultrafine Aerosols during Deep Convection at the Southern Great Plains. MANISHA MEHRA, Scott Giangrande, Jian Wang, Yang Wang, *University of Miami*

Recent studies have shown the potential of deep convection in introducing aerosols from the free troposphere (FT) into the boundary layer (BL), influencing the cloud condensation nuclei in the BL and subsequent aerosol-cloud interactions. This study characterizes the vertical transport of ultrafine aerosols (especially those with diameter <50 nm) from the FT to the BL during deep convective cloud events at the U.S. Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) Southern Great Plains (SGP) observatory from January 2019 to December 2023. Deep convective events are identified based on (1) convective cloud tops exceeding 8 km above ground, (2) the radial wind velocity (Vr) exceeding 5 m s-1 near the surface, and (3) a decrease in the equivalent potential temperature (θE) of more than 3 K within 10 minutes at the surface. Amongst the identified 88 events that had concurrent aerosol size distribution measurements, 40 (46%) exhibited a notable increase in fraction contribution of ultrafine particles to the total number concentration within two hours after deep convection onset, compared to two hours before the event (59±13% after and 36±17% before deep convection). Moreover, 26 events (30%) exhibited significantly higher absolute number concentrations of ultrafine particles after deep convection. The Vr in the convective core together with the decrease of θE indicate the downward motion of air mass from the FT to the BL, facilitating the vertical transport of these ultrafine particles. Decreased mixing ratio of carbon monoxide (18 ± 11%) and increased mixing ratio of ozone (27± 25%) during these events also suggest downdrafts of FT air into the BL. We analyzed the horizontal wind directions before and after the events to exclude the effects of horizontal transport. The details on event identification and the implications of deep convection on aerosol dynamics at the SGP will be further discussed.

9CC.7

Exploring Particle Dynamics: Preliminary Investigations in Wear Particle Measurement for Tire and Road Surfaces. VOLKER ZIEGLER, Henrik Hof, Danilo Engelmann, Markus Barth, *Palas GmbH, Karlsruhe, Germany*

This paper presents ongoing research conducted in collaboration between the BFH (Bern University of Applied Sciences) and PALAS GmbH focusing on the analysis of wear particles originating from tire and road abrasion. The ultimate objective is to develop the capability to directly measure particles from rolling tires using an ISO-kinetic sampling method, enabling precise spatial resolution of particle distribution. This entails examining particle dynamics in correlation with driving conditions and associated parameters such as slip angle, axle loads, and road surface characteristics. Additionally, the impact on Tire and Road Wear Particles (TRWP) is investigated through a progression from laboratory-based tire testing to controlled roller rig experiments and on-road trials, incorporating increasingly diverse influencing factors.

The article outlines the current preliminary project, detailing the developmental and validation steps of the requisite measurement setup and technology. Validation of the measurement setup is performed using an electric microcar as a test case, demonstrating its suitability for both stationary and mobile applications. The derivation of system requirements, selection of measurement technology, and validation of sensor choices, including particle size scanning from 3 nm to approximately 400 µm, are elucidated. Subsequently, the paper delineates the measurement concept encompassing suction, sensors, flow meters, and calibration methodologies using various particle generators. Results from different measurement concepts are presented and evaluated in the context of the overarching project goals.

Furthermore, the paper reports on measurements conducted on the microcar on the testbed, chosen for its lightweight and low power characteristics posing significant measurement challenges. Results from two operating points are discussed alongside preceding findings, offering insights into the project's progression and outlining future steps. This comprehensive overview contributes to advancing understanding of particle dynamics in relation to driving conditions and paves the way for further advancements in this field.

9CC.8

Aircraft Observations of Ice Nucleating Particles in the Arctic and Sub-Arctic Boundary Layer and Free Troposphere. RUSSELL PERKINS, Ryan Patnaude, Camille Mavis, Kevin R. Barry, Paul DeMott, Sonia Kreidenweis, Paquita Zuidema, Bart Geerts, Greg McFarquhar, Sebastian Schmidt, *Colorado State University*

Ice Nucleating Particles (INPs) are responsible for primary cloud glaciation warmer than -38 °C, and a critical control on secondary ice production processes. Mixed-phase clouds fall into this temperature range and are common in the spring and autumn transition seasons in the Arctic, and during wintertime cold-air outbreak (CAO) events, where cold airmasses over the Arctic ice flow southward over North Atlantic open water. Two recent campaigns, across three deployments, have targeted these cloud types with an extensive suite of instrumentation, but we will focus on INP measurements here. The Cold-Air outbreak Experiment in the Sub-Arctic Region (CAESAR) occurred in Feb-April of 2024, targeting CAO events over the Norwegian Sea and Greenland Sea. Several strong and weak CAO events were captured, including events with evidence of long-range transported terrestrial aerosol from Europe, Asia, and Africa. Evidence of elevated INP concentrations is found over the marginal ice zone, potentially related to increased biological production. The Arctic Radiation-Cloud-Aerosol-Surface-Interaction eXperiment (ARCSIX) will occur with two deployments, one in May-June and another in July-August of 2024, targeting different sea ice and cloud systems in the Lincoln Sea and surrounding areas. This presentation will discuss preliminary findings from both campaigns, with a special focus on local arctic sources and long-range transported aerosol and the roles of INPs sourced from above and below clouds.

9CC.9

Confronting Structural Uncertainty in Aerosol Effects on Climate. LAURA FIERCE, Jeffrey Johnson, Kadja Flore Gali, Joscelyne Guzman - Gonzalez, Payton Beeler, Will Cantrell, Rosa M. Fitzgerald, Matthew Dawson, Benjamin Murphy, Nicole Riemer, *Pacific Northwest National Laboratory*

Aerosol effects on clouds and radiation are a large source of inter-model variability in radiative forcing among climate models. Climate-relevant aerosol properties depend critically on the distribution in size, shape, and chemical composition of particle populations that evolve in time as they are transported through Earth's atmosphere. However, tracking such particle-level details is computationally impractical for large-scale, long-running climate simulations. Instead, aerosol modules in large-scale atmospheric models necessarily simplify the representation of particle characteristics, leading to errors in climate-relevant aerosol properties that have not been well quantified. Here we present a framework for using particle-resolved simulations of aerosol-cloud-chemistry interactions to quantify structural errors from the numerical representation of particle population. Based on this analysis, we then show how these detailed aerosol schemes can be used to improve aerosol parameterizations in large-scale models. Through this approach, we aim to inform the development of aerosol schemes that balance model accuracy with computational efficiency, while also characterizing uncertainty from reduced representations of particle populations.

9CC.10

Aircraft Engine Particle Emissions during the 2023 NASA-Boeing ecoDemonstrator Field Measurements. FRANCESCA GALLO, Steven Baughcum, Matthew Brown, William M Griffin, Carolyn Jordan, Michael Shook, Elizabeth Wiggins, Edward Winstead, Luke Ziemba, Richard Moore, *NASA Langley*

Aerosol aircraft emissions are responsible for the formation of contrail cirrus clouds which can alter Earth's radiation and water budgets exerting substantial effects on climate. However, at present, the impact of aviation on climate forcing remaining uncertain. Recently, NASA has collaborated with Boeing ecoDemonstrator program to improve the understanding of air traffic emissions and the impact of different jet fuel compositions on contrail microphysics. As part of the program, in October 2023 the NASA DC-8 aircraft was used to sample engine exhausts emitted by a Boeing ecoDemonstrator Explorer 737-10 burning sustainable aviation fuel (SAF) and conventional jet fuel over the north western US. In this study, we present unique observations of aerosols properties relevant for contrail-cirrus cloud formation collected during the 2023 ecoDemonstrator research flights and we will discuss the variations of key microphysical contrail parameters in function of different jet fuel compositions and engine conditions.

9CC.11

Overview of the 2023 Boeing ecoDemonstrator Emissions Flight Test. RICHARD MOORE, Steven Baughcum, Tiziana Braeuer, Matthew Brown, Andrew Freedman, Francesca Gallo, William M Griffin, Francisco Guzman, Jennifer Klettlinger, Richard Miake-Lye, Benjamin A. Nault, Daniel Sauer, Michael Shook, Gregory Smallwood, Christiane Voigt, Phil Whitefield, Elizabeth Wiggins, Edward Winstead, Luke Ziemba, 2023 Boeing ecoDemonstrator Explorer Science Team, *NASA*

Aircraft engines emit sub-30 nm soot particles and nucleation mode droplets that have impacts on the local air quality near airports as well as in the formation of climate-altering contrail cirrus clouds. It is currently thought that the radiative forcing from these contrail cirrus today is of similar magnitude to that from the cumulative carbon dioxide emissions since the dawn of the jet age. Sustainable aviation fuels (SAF) are a promising pathway for helping to meet the Biden Administration's goal of net-zero aviation carbon dioxide emissions by 2050. Replacement of older airplanes with current production airplane/engine technology and SAFs are likely to be 100% of the solution through 2030 and still play a big role even in 2050. NASA-funded research has shown that SAFs have important co-benefits for reducing engine particle emissions, and the improvement can be even greater when pairing SAFs with advanced, low-emitting lean burn engine technology.

Recently, NASA, Boeing, GE Aerospace, United, DLR, Aerodyne Research, and other national and international partners measured the particle emissions and contrail properties behind a Boeing ecoDemonstrator Explorer 737-10 burning both conventional Jet A fuel and 100% SAF. While dramatic soot particle number emissions reductions were apparent, large numbers of volatile nucleation mode particles were measured even after carefully controlling the fuel composition to minimize sulfur content. The implications of these nucleation mode particles as potential seeds for contrail ice crystals will be discussed.

9CC.12

Splash-Plate Atomization as a Candidate Spraying Technique for Marine Cloud Brightening.

MARYAM SHAHRASEBI, Steven Rogak, *University of British Columbia*

Marine Cloud Brightening (MCB) has been proposed as a technique to produce local or regional cooling over remote oceans. The underlying principle of MCB is to artificially enhance the reflectivity and longevity of the maritime stratocumulus clouds by injecting seawater aerosols at low elevations. 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 (median of 30-100 nm).

Splash-plate atomization (SPA) uses jet impingement on an inclined plate to develop a thin liquid sheet that subsequently breaks into droplets of a size comparable to the sheet thickness rather than the orifice diameter. We measure the energy consumed by SPA from liquid flow and pressure, and with the size distribution (Scanning Mobility Particle Spectrometer and Electrical Low-pressure Impactor), we estimate the energy required for a particle of the correct size. SPA requires in the order of 10^{-9} J/particle, comparable to current state-of-the-art effervescent atomizers being field tested for MCB. Plate angle, orifice diameter, and jet velocity influence the efficiency of SPA.

9CC.13

The Diverse Physicochemical Mixing State of Aerosol Particles during TRacking Aerosol Convection inteRactions Experiment (TRACER) Campaign.

ZIYING LEI, Seth Thompson, Bo Chen, Taylor Peña, Brianna Matthews, Ron Li, Anita Rapp, Christopher Nowotarski, Sarah D. Brooks, *University of Tennessee*

To improve our understanding of how aerosols influence cloud properties in convective storms, we aim to provide detailed physicochemical characterization of individual submicron aerosols collected during the DOE’s TRacking Aerosol Convection inteRactions Experiment (TRACER) in the Greater Houston Area. In this study, computer-controlled Raman microspectroscopy was used to provide detailed morphology and chemical composition of thousands of individual particles. Our results reveal a great diversity of aerosols during the TRACER campaign, with significant differences in morphology (i.e., core-shell, homogeneous, and complex mixing) and chemical composition between coastal and inland locations. During hot summer days, development of the sea breeze often led to the initiation of convective storms in the urban area. Inland propagation of the sea breeze resulted in air masses that originated in the Gulf of Mexico passing over the Galveston sampling site, over central Houston, and to our inland sampling location. During sea breeze convective days, particles near the Gulf of Mexico exhibited a higher percentage of organic compounds, ranging from 69.6% to 97.8%, while those at the inland site contained a higher percentage of inorganic compounds, ranging from 5.0% to 41.4%. Additionally, variations in aerosol morphology and chemical composition were linked to differences in cloud condensation nucleation concentrations observed between the coastal and inland locations. The observed variations in aerosol characteristics illustrate the challenge of attributing any observed changes in convective cloud systems to aerosols, as the aerosol inputs vary from airmass to airmass. Our study enhances understanding of aerosol physicochemical properties and their role in microphysics and aerosol-cloud interactions during TRACER.

9CC.14

Stratosphere and Troposphere Aerosol Exposure Studies (STAES).

ANDRES SANCHEZ, *Sandia National Laboratories*

Aerosol-climate interactions account for one of the larger uncertainties in traditional climate models. Aerosols modify the Earth's radiative budget, through scattering and absorption or by influencing the size and lifetime of clouds. The magnitude of these effects depends on the size and chemical nature of the aerosol particles properties that vary with emission location and the time spent interacting with the atmosphere. Thus, aerosol impacts on climate are difficult to quantify, as they are global-scale manifestations of microscale processes that are entangled with meteorological variability.

This project is developing a unique capability utilizing a novel transport vessel to expose aerosol materials to Earth’s atmosphere at various altitudes and subsequently apply nanoscale surface science to characterize the effects. This effort is aimed at gaining a fundamental mechanistic understanding of how reactive atmospheric species alter the surface structure and chemistry of airborne aerosols. The project will benchmark how atmospheric processing of aerosols effects their climate-forcing mechanisms and provide critical experimentation on methods of climate intervention.

9CC.15

Organic Acids in Cloud Water, Aerosols, and Cloud Droplet Residuals at the Summit of Whiteface Mountain (WFM).

ARCHANA TRIPATHY, Christopher Lawrence, Haider Khwaja, Mirza M. Hussain, Elizabeth Yerger, Phil Snyder, Paul Casson, Rudra Patel, Sarah Lombardo, Lily Hammond, Richard Brandt, Scott McKim, William May, James Schlemmer, Dan Kelting, James Schwab, Sara Lance, *University at Albany*

Organic compounds in the atmosphere play a pivotal role in atmospheric chemistry, and clouds are significant in the genesis and alteration of these compounds. Di-carboxylic organic anions such as oxalate serve as tracers for aqueous processing. This poster details our findings from summer measurements of three major organic acids (formic acid, acetic acid, oxalic acid), as well as inorganic anions (sulfate, chloride, nitrate) and cations (sodium, potassium, ammonium, calcium, magnesium) in cloud water, aerosol, and cloud droplet residual samples collected at the summit of Whiteface Mountain (WFM) in the Adirondack Mountains, northern New York State. We also evaluate the contribution of these organic acids to water-soluble organic carbon (WSOC) concentrations. Previous studies have explored the oxalate: WSOC ratio with ozone levels, aiming to deduce the influence of biogenic Volatile Organic Compounds (VOCs) on Secondary Organic Aerosol (SOA) formation from nearby forest ecosystems. Our poster presents new observations that significantly broaden this understanding by comparing to diverse global environments and analyzing both cloud water and aerosol phases. Additionally, we introduce oxalate: sulfate ratios from our dataset, proposed by other researchers as a key indicator of aqueous processing due to the enhanced production rates of these ions by liquid water content (sulfate ion) or droplet surface area (oxalate ion). We compare the observed range of oxalate: sulfate ratios with those from field campaigns conducted in other regions. Moreover, for the first time, we examine the relationship between ammonium and organic acids across cloud water, aerosol, and droplet residual samples collected in 2023, and discuss the influence of wildfire smoke on these dynamics.

9CE.2

Oxidation of the Neonicotinoid Acetamiprid on Particles and Solids by OH Radicals: Top-Down versus Bottom-Up.

WEIHONG WANG, Xinke Wang, Lisa Wingen, Véronique Perraud, Barbara Finlayson-Pitts, *University of California Irvine*

Emerging contaminants (EC) are widely distributed on particles and other environment surfaces. They can be oxidized by gas phase species or by oxidants generated by underlying substrates. This may result in more toxic products, posing risks to both humans and the environment. Neonicotinoid (NN) pesticides which have been widely used since 1991 fall under the umbrella of EC. They have been found on airborne particles and other surfaces in the environment, resulting in widespread dispersion and the potential for human exposure. In addition, they have been associated with bee colony collapse. Oxidation of the NN pesticide acetamiprid (ACM) by the OH radical was studied where the ACM was on particles or on solid substrates. Hydroxyl radicals were generated either in the gas phase where the radicals attacked the solid ACM from the top down, or from an underlying TiO_2 or $NaNO_2$ substrate that generates OH on photolysis and attacks the ACM from the bottom up. The major products, mechanisms and kinetics of OH oxidation of ACM under both circumstances will be reported and compared to oxidation in the aqueous phase. The results of this study highlight the different potential oxidation processes for EC and provide key data for assessing their environmental fates and toxicology.

9CE.3

Investigating Atmospheric Emissions of Nanoplastic Fibers from Residential Laundry Activities: A Study Using Aerosol Mass Spectrometry.

MICHAEL A.R. TAWADROUS, Alex K.Y. Lee, Arthur W. H. Chan, *University of Toronto*

Microfibers and nanofibers shredded from textiles play a significant role in the transport and distribution of chemical pollutants in the atmosphere due to their emission levels and capacity to adsorb other contaminates. Laundry activities represent a prominent source of airborne micro- and nanoplastic fibers. While numerous studies have examined microplastics, the quantification of laundry activities' contribution to nanoparticle pollution remains unclear due to the analytical complexities associated with detecting and characterizing these tiny fibers.

In our research, we use both online (AMS and SMPS) and offline (Py-GC/MS and SEM) techniques, which have previously been validated for the characterization of atmospheric nanoparticles in our previous study, to characterize and quantify atmospheric nanofibers. Analyzing the polymeric composition derived from the mass spectra generated by both AMS and Py-GC/MS will provide valuable insights into the sources of these fibers in the atmosphere. Nanofiber emissions are sampled from a vented dryer to investigate whether the mechanical drying of textiles releases nanofibers into the air or if they are instead captured and contained by the dryer's integrated filtration system. Various textile materials, including polyester (synthetic textiles) and cotton (natural textiles) blankets, are used as sources of nanofibers emitted during laundry drying. Emissions from different drying programs (hot, warm, and cool dry) operated within a temperature range of 25 to 60 °C, are examined to understand their impact on nanofiber release.

The preliminary results showed that the AMS detected chemical compounds and quantified the organic mass concentrations of nanofibers generated from drying polyester blankets. Information on nanofiber chemical composition provided by AMS and Py-GC/MS was used to determine marker ions of shredded polyester nanofibers such as those at *m/z* 149 and 166. As drying goes from the hot to cool cycle, the nanofiber mass concentrations obtained from both AMS and SMPS were significantly decreased.

9CE.4

Effect of Print Speed on Airborne Plastic Emissions from Fused Deposition Modeling 3D Printing.

JUSTIN MORROW, Alyssa Yerkeson, Xiangjing Gao, Jun Wang, *University of Cincinnati*

Over the last 10 years, fused deposition modeling (FDM) 3D printing has become a fast, effective, and affordable method for creating plastic components from plastic filament. Emission studies have consistently found that FDM produces particulate aerosol that can vary in concentration by more than 5 orders of magnitude depending on process parameters and printed material. One understudied process parameter is printing speed – high speed printers released in the last two years now advertise maximum plastic extrusion rates of 30 – 50 mm^3/s while the highest rate found in the literature is roughly 9 mm^3/s. Therefore the two objectives of this study are (1) to develop standard methods for isolating the plastic extrusion rate and printing speed as key variables in FDM emission studies and (2) to apply these methods to study the impact of print speed on total aerosol exposure from high speed FDM 3D printing. A high speed 3D printer was operated with increasing speed of up to 22 mm^3/s of commanded extrusion and emissions were measured by SMPS, OPS, and air quality monitors. The results showed aerosol mean particle size in the ultrafine range (< 100 nm) with concentration as high as 3.5×10^5 cm^{-3} and particle emission rate as high as $3x10^{11}$ particles/hour – consistent with previous literature. However unlike previous literature, two experimental studies on emissions vs. speed both showed a nonlinear effect with the maximum emissions found roughly midway in the speed range. Initial calculations of particle yield per unit printed mass also indicated an overall reduction in specific particle yield with printing speed. Therefore we present that high speed printing can offset increased emission rate by lowering print time when printing a single object and that printing emissions (and therefore worker exposure) can be considered as a factor when setting FDM printing parameters.

9CE.5

Understanding Microplastic Aerosols: Clouds, Precipitation, and Beyond.

ALEXANDRIA JOHNSON, Gouri Prabhakar, *Purdue University*

Plastic has become a ubiquitous material in modern day life. The plastics we use, and discard, can take upwards of 500 years to decompose. Even then, the material itself never actually disappears; it just breaks down in to smaller and smaller pieces. In recent years these small pieces, known as microplastics and nanoplastics, have been found almost everywhere, from the guts and gills of fish in the great lakes, to remote locations like Antarctica and the world's highest peaks. Identifying the role these tiny bits of plastic play in our environment now is key to understanding our changing world and assessing how the role of plastics will change with time.

In this research we are working towards understanding the presence of microplastics and nanoplastics in two ways. The first is the identification and quantification of microplastics from rain and snow collected in the Greater Lafayette, Indiana region. Samples collected at the ground from the summer of 2023 onward are being analyzed to identify plastics through microscope and SEM images. Additional data collected on site allows for us to link the presence of plastics with the overall meteorological (wind speed, temperature, time since last rainfall, etc.) and microphysical (drop size distribution, cumulative precipitation, etc.) conditions of rain and snow events. Second is investigating how these plastics become integrated into clouds and precipitation and the effects they have on cloud microphysical processes through laboratory studies. In particular, we are working towards isolating microplastics and nanoplastics from events in such a way that mechanical and chemical aging is preserved, allowing for their nucleation and chemical properties to be analyzed through controlled experiments.

9CE.6

OH-initiated Heterogeneous Oxidation of Nanoparticles from Plastic Combustion. LIN KONG, Hongru Shen, Alex K.Y. Lee, Arthur W. H. Chan, Man Nin Chan, *The Chinese University of Hong Kong*

The widespread use of plastics and their subsequent incineration treatment significantly contribute to environmental pollution, particularly in the form of atmospheric nanoplastic particles (NPP) that can have deleterious effects on human health and ecosystems. Additionally, with the expected increase in intensity and frequency of wildfire activities, NPP emissions from combustion sources are expected to increase. After emitting, NPP can undergo heterogeneous reactions, potentially forming secondary products and changing their physical and chemical properties. However, understanding of the heterogeneous transformation of these NPP remains limited. In this study, we investigated the heterogeneous reactions initiated by OH radicals of NPP from plastic combustion, including polyethylene (PE), polypropylene (PP), polystyrene (PS), polyvinyl chloride (PVC), and polyethylene terephthalate (PET) in a flow reactor. The chemical composition and size of the NPP were characterized using a scanning mobility particle sizer (SMPS) and a time-of-flight aerosol mass spectrometer (ToF-AMS). Distinct changes of NPP were observed in the AMS mass spectra upon oxidation, for example, the decreased $C_xH_y^+$ and increased $C_xH_yO_z^+$ signals, and a rise in the O/C ratio and the OS_C at a maximum OH exposure of 2.2×10^{11} molecules cm^{-3} s. We propose that a hydroxyl or a carbonyl functional group was likely added to each repeating unit of NPP during heterogeneous reaction. Furthermore, we employed Pyrolysis Gas Chromatography-Mass Spectrometry (Py-GC-MS) to identify the polymeric backbone alterations and the formation of oxidative compounds due to oxidation. The study also examined the impact of particle size on oxidation kinetics and demonstrated that smaller NPP exhibit higher oxidation rates due to their increased surface area-to-volume ratio. The findings of this study help us understand the atmospheric fate of NPP through heterogeneous oxidation. Our results highlight the evolution of NPP composition in the atmosphere, which should be considered in air quality modeling and health risk assessments.

9CE.9

Determination of Settling Velocity of Airborne Metal Debris. WILLIAM CASPINO, Enrica Viparelli, Shamia Hoque, *University of South Carolina*

Transport and deposition of debris are sources of environmental and public health concern. Controlled laboratory experiments and modeling are in progress to determine how deposition velocity distribution varies with particle type. Results will aid in field tests on contamination by metal debris generated from a radioactive fallout. The tests will be conducted in a rural environment by releasing the particles at a specific height under varying atmospheric conditions. This study performs laboratory experiments in a controlled environment consisting of a 1.2 m tall, scaled test chamber with a 0.5 m squared base within which particles are released under stagnant conditions. Electron microscopy images of the particles revealed that the particles are not spherical, and the size range is between 400 and 1000 µm. Transport through the column was tracked utilizing a Phantom v7.3 camera. Particles were categorized into three size bins with deposition velocity ranging from 1.71 m/s to 2.67 m/s depending on particle diameter. Size bin one contained particles with diameters finer than 500 µm, size bin two contained particles with diameters ranging from 500 µm to 800 µm, and size bin three contained particles with diameters larger than 800 µm. For size bin one, velocity estimates of five particles ranged from 1.71 m/s to 2.09 m/s. For the second size bin, the velocity measurements of six particles varied between 2.28 m/s to 2.38 m/s. For the third bin, nine velocities were measured with values between 2.47 m/s and 2.67 m/s, confirming that particle velocity increased with size. Preliminary results further indicated that steady-state conditions might have been achieved for the finest particles. Finally, Reynolds number estimates, as well as the irregular particle shape, suggest that Stokes' law assumptions cannot be applied to determine the deposition velocities of these particles.

9CE.10

Analysis of Tire and Road Wear Particles Generated from a Microplastic Chamber. ABBY AYALA, Rebecca Parham, Madeline Clough, Anne McNeil, Andrew Ault, *University of Michigan*

Plastics are heavily integrated into the Anthropocene’s framework due to their environmental resilience and mismanaged waste. Small plastics, often referred to as microplastics (1–5000 µm), can be suspended in the atmosphere, contributing to both climate and health impacts. Most research on vehicle pollution is focused on soot and secondary species formed in exhaust, but tire and brake abrasion also generates atmospheric microplastics. These non-exhaust vehicle emissions are complex materials, containing not only microplastics but also road debris, among other components. Lab-generated samples isolated from other sources are needed to determine the physicochemical properties of such emissions, however, traditional abrasion simulators have limited accessibility due to their size and cost. Herein, we characterize a microplastic chamber, designed in-house utilizing a rotary tool, to allow for convenient and dry generation of tire and brake-wear particles. Once the chamber's efficacy was verified by size distributions, samples were collected via inertial impaction and analyzed with vibrational spectroscopy, specifically optical photothermal infrared (O-PTIR) + Raman microspectroscopy. The simultaneously collected submicron infrared and Raman spectra are improving existing libraries and enabling comparison to ambient samples so that components contributing to atmospheric microplastic concentrations can be identified.

9CE.11

Laboratory Study of the Contribution of Phenolic Resin Thermal Degradation to Automotive Brake Emissions. BERENICE ROJAS, Adam Thomas, Lisa Wingen, Madeline Cooke, Véronique Perraud, Barbara Finlayson-Pitts, James Smith, *University of California, Irvine*

Understanding vehicle emissions is crucial in mitigating poor air quality. The national trend towards electric vehicles has reduced tailpipe emissions but has left non-tailpipe emissions such as brake and tire wear as significant contributors to emissions. Most modern passenger vehicles use ceramic or semi-metallic brake pads, including phenolic resins as binder agents that undergo frictional heating during braking. Severe braking conditions can lead to the decomposition of these resins, increasing wear and releasing harmful ultrafine particles (UFPs) into the environment. While it is known that braking can emit UFPs, the contribution of different brake pad materials and the impact of phenolic resin decomposition on the formation and composition of these particles remain unclear. In this study, we investigate the chemical composition of UFPs from the thermal degradation of phenolic resins and compare them with emissions from a light-duty vehicle disc brake system equipped with ceramic and semi-metallic brake pads. In the thermal degradation experiments, phenolic resin samples were heated in a controlled manner to simulate thermal heating during braking, releasing volatile organic compounds, which resulted in the direct nucleation of UFPs. In the disc brake simulation experiments, a custom-built brake dynamometer was used to simulate braking over various operating conditions in real-world driving. UFPs formed from the disc brakes and phenolic resin heating experiments were collected on filters and analyzed using liquid chromatography coupled with high-resolution Orbitrap mass spectrometry. By comparing composition data obtained during these experiments, we identify key contributors to UFP formation from brake pads, guiding the development of improved brake pad materials that minimize environmental and health impacts. Our findings will highlight the importance of brake pad composition and its impact on air quality.

9CM.1

Characterization of Dust Generated from Grinding Natural and Engineered Stones.

DREW THOMPSON, Chaolong Qi, *NIOSH*

Outbreaks of silicosis have been reported among stone countertop fabrication workers in the United States. Due to the high crystalline silica content in engineered stone, which can exceed 90%, dust controls currently employed in some fabrication worksites may not adequately limit exposure levels. In this study the dust generated by grinding natural and engineered stones was systematically characterized in a laboratory testing system. The stones tested included two engineered stones of crystalline silica in a polyester resin matrix (Stones A and B), an engineered stone of recycled glass in a cement matrix (Stone C), and granite. Particle size distributions were measured by Aerodynamic Particle Sizer. Aerosol samples were collected by respirable samplers, total dust samplers, and Micro-Orifice Uniform Deposit Impactor. Bulk dust samples were collected from the dust settled on the floor of the testing chamber. Samples were analyzed by gravimetric analysis and X-Ray diffraction to determine dust generation rates, crystalline silica generation rates, and crystalline silica content. No crystalline silica was detected in the bulk dust of Stone C. Stone A, Stone B, and granite bulk dust were 60%, 23%, and 30% crystalline silica, respectively. The crystalline silica content in bulk dust, respirable dust, and total dust were comparable for each stone type. Granite generated more dust per unit volume of material removed than the engineered stones, which all had similar dust normalized generation rates. Stone A had the highest crystalline silica normalized generation rates, followed by granite, Stone B, and Stone C (non-detect). For all stones containing crystalline silica, the highest size-dependent, normalized generation rate of respirable crystalline silica occurred at 3.2-5.6 µm. All stones generated similar trimodal lognormal particle size distributions, with the most prominent mode at 2-2.3 µm. These results will aid in the selection or development of optimal exposure control measures.

9CM.2

Granular Bed Filter Model for Porous Filter Media.

JAE-HYUN PARK, Myong-Hwa Lee, *Kangwon National University, University of Miami*

Air filters play a crucial role in separating and capturing airborne particles. There are two types of filter media such as a fibrous filter, which fibers are intricately intertwined, and porous filters, featuring randomly distributed pores. The selection of a desirable filter suitable to its application is important. The filtration performance of a fibrous filter can be predicted by a Davies' equation (pressure drop) and a log-penetration equation (collection efficiency). However, there is no reliable method to predict the filtration performance of a porous filter.

A potential method to predict the filtration performance of a porous filter was suggested by using a granular bed theory in this study. Porous filter was regarded as a granular bed filter composed of packing materials. The shape of a packing material was determined by a fiber structure among open cells. Pressure drop of a porous filter could be calculated by Ergun equation and the collection efficiency could be predicted by a log-penetration equation using a single sphere theory. The results revealed that those prediction equations, which are Ergun equation and log-penetration equation considering a shaper factor and variance of the spheres, were applicable to porous filter media.

Acknowledgment
This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korean government (MSIT) (No. RS-2023-00249948).

9CM.3

Enhanced Particle Removal by Electrosprayed Charged Droplets in a Scrubber.

JOON YUB KIM, Myong-Hwa Lee, *Kangwon National University*

Wet scrubbing system is widely used to remove particulate matter and gaseous species. However, its particle removal efficiency is not high enough to satisfy the reinforced national regulation. Therefore, a potential method to increase the collection efficiency is required. The installation of an electrospray system can be a good alternative to improve the performance of a wet scrubber. Charged droplets generated by electrospraying can capture the fine particles more effectively by electrostatic attraction. However, the resultant droplet size is more important to be removed in a wet scrubber. Once the droplet size is too small, it can be discharged with fluid stream. In addition, high liquid to gas ratio is required to increase the particle collection efficiency in a wet scrubber. Most of recent studies about electrodynamic atomization have focused on the low liquid flow rates.

In this study, electrospray using a tap water was conducted at the liquid flow rates of 100~500 milliliters per minute, and the characteristics and size distribution of the resultant charged droplets were measured and compared based on the electric field orientation, liquid flow rates, and electrical conductivity. Additionally, particle removal efficiency was measured to investigate the effect of the charged droplets generated by electrospray.

Acknowledgment
This study was supported by the Korea Environmental Industry & Technology Institute grant funded by the Korean government (Ministry of Environment) (No. RS-2023-00219242).

9CM.4

Optimized Structure of Nano-Micro Composite Filter for Increased Filter Lifetime.

MIN-SEON KWON, Myong-Hwa Lee, *Kangwon National University, University of Miami*

Air purifier generally utilizes disposable fibrous filter to remove fine dust. The performance of a fibrous filter used in an air purifier is evaluated by collection efficiency and pressure drop. Higher collection efficiency and lower pressure drop provide superior filtration performance. Electret filter collects particles not only by mechanical mechanisms such as diffusion, interception and inertia, but also by electrostatic attraction, resulting in higher filtration performance. Hence, electret filters are usually used in air purifiers. However, the filter should be periodically replaced as particles are deposited inside, leading to decreased dust collection efficiency by decreased electrostatic force and increased pressure drop by dust loading. Therefore, it is necessary to figure out how to increase filter lifetime by lowering the increment of pressure drop and maintaining the filter collection efficiency. Recently, many researchers have studied the nanofiber filters in order to improve the filtration performance of an air filter. However, nanofiber filters have the disadvantage of low dust holding capacity (the maximum dust amount that the filter can hold, DHC). Therefore, a nano-micro composite filter has been suggested as a potential way to decrease the increment of pressure drop and to improve filtration performance. In addition, it is expected that the filter lifetime can be different by stacking order of filter layers in a multi-layered filter. To validate this concept, the effect of stacking order of filter layers in nano-micro composite filters with three fiber layers on filter performance, pressure drop, and DHC by dust loading was investigated. In addition, the filtration properties of individual layer in uncharged and charged nano-micro composite filters were analyzed in order to quantify its pressure drop and DHC.

Acknowledgment
This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korean government (MSIT) (No. RS-2023-00249948).

9CM.6

Collection Of Condensed Vapors from Biomass Slow Pyrolysis Processes.

Muhammad Wasiq Riaz, Andrea Facchin, Vincenzo Gentile, Cristian Torri, PAOLO TRONVILLE, *Politecnico di Torino*

Biomass pyrolysis can produce charcoal for several applications. For example, the "Biomet" project studies how to transform the wood waste of the furniture industry into a renewable carbon-rich char for metallurgical use.

Along with char, biomass pyrolysis produces a gas (syngas, formed by hydrogen, carbon monoxide, methane, and other incondensable) and a condensable liquid. Upon cooling, the latter yields an ultrafine aerosol whose separation is required to obtain a clean gas, reduce environmental pollution, and turn it into a resource whenever possible. The liquid obtained from slow pyrolysis (also called wood vinegar) can be considered a high-value by-product in the preparation of biochar by biomass pyrolysis. As a natural fungicide, wood vinegar has great potential to control plant disease, achieve more sustainable agriculture, and avoid the massive use of pesticides.

We present some experimental results obtained employing a slow pyrolyzer operating with a closed-loop principle to produce metallurgical char and slow pyrolysis liquid and relatively clean syngas. The FumeCatch reactor adopts an innovative cooling-down principle and a cyclone to maximize the separation of condensed vapors. It cools down suddenly the pyrolysis fumes, mixing the hot flow with a recirculated cold fraction. This way, we can study the effect of the cooling and cyclone collection efficiency on yield and composition in the pyrolysis liquid. Aerosol collection efficiency was quantified, showing cyclone geometry's and operating parameters' important effect on the collection efficiency.

Quantifying and analyzing this new technology's prototype output showed some promising results. The biochar yield with slow pyrolysis of wood waste exceeded 30% by mass. The chemical analysis of the obtained bio-oil suggests that Fumecatch collects primary pyrolysis products of slow pyrolysis, minimizing the unwanted post-pyrolysis reactions (e.g., formation of polycyclic aromatic hydrocarbons and other secondary products). Water constitutes most bio-oil, accounting for 67% by mass; the remaining 33% comprises various chemicals (acetic acid, levoglucosan). According to the results, FumeCatch can be considered a relatively simple way to recover the condensable/aerosol-forming fraction from slow pyrolysis. Hence, it can decrease the amount of particulate matter released from small-scale thermal treatment devices and maximize wood vinegar production with relevant applications in several decentralized biomass valorization schemes (e.g., charcoal manufacturing and agricultural residue management).

This study was carried out within the MICS (Made in Italy – Circular and Sustainable) Extended Partnership and received funding from Next-GenerationEU (Italian PNRR – M4 C2, Invest 1.3 – D.D. 1551.11-10-2022, PE00000004).

9CM.7

Impacts of HVAC Cleaning on Energy Consumption and Supply Airflow: A Multi-Climate Evaluation.

NASIM ILDIRI, Mark Hernandez, *University of Colorado Boulder*

Energy-efficiency interventions are crucial for sustainable building operations that integrate emerging indoor air quality (IAQ) criteria into their engineering life cycles. While several studies address building energy consumption and IAQ considerations separately, few provide integrated analysis of these aspects in response to building hygiene practices. In response this study evaluates the effectiveness of routine heating, ventilation, and air conditioning (HVAC) cleaning on the energy consumption and supply airflow patterns in non-residential public buildings. This study juxtaposes HVAC energy consumption and ventilation performance before, during and after routine HVAC cleaning, across four groups of buildings situated in different climate zones in cooling mode. Each site had nearly identical HVAC systems serving similar architectural features and occupational loads, which were segregated into an intervention (cleaned HVAC system) that could be compared to an otherwise identically operating HVAC (control system), which was not cleaned. Cleaned HVAC systems exhibited a significant reduction in energy consumption and consistently delivered higher airflow compared to uncleaned counterparts. This research demonstrates how a generation of affordable IAQ and HVAC system monitors can compile IOT archives to show immediate energy consumption benefits associated with cleaning the HVAC components and the ductwork in relatively high occupancy commercial and educational spaces.

9CM.8

PIV Visualization of a Sinusoidal EHD Confinement Flow Induced by Variation in Ion Density for Electrostatic Particle Clustering.

MD EYASIN HOSSAIN, Eric Monsu Lee, *Northern Illinois University*

Fine particulate matter, commonly known as PM2.5, is accountable for around four million deaths worldwide due to cardiovascular diseases. Fabric filters have been utilized for particle pollution control in industrial and indoor settings. However, the maintenance cost of fabric filters is high as particle accumulation on filters can lead to higher pressure drop and energy consumption as well as the growth of biological organisms and the generation of airborne pathogens. Electrostatic precipitators (ESPs) are an alternative approach widely used in the power industry, mainly for collecting coal fly ash. ESPs can achieve more than 99% of particle collection efficiency but also suffer from low collection efficiency of PM2.5 and ozone generation. Therefore, ongoing research is toward developing modern ESPs to control PM2.5 with minimal ozone emission. The optimization of discharge and collection electrodes substantially impacts the ion distribution and thus the collection of particles in an ESP. Earlier works mostly centered on modifying the geometry of collection electrodes with less focus on discharge electrodes. This study centers on the collective behavior of unipolar charged particles in a longitudinal wire-plate ESP by inducing variation in ion density through discharge electrode modification. It is hypothesized that the modified discharge electrode could create a sinusoidal flow, promoting electrostatic particle clustering and ultimately enhancing the particle collection efficiency of PM2.5. A 2D-2C Particle Image Velocimetry (PIV) enabled by a double pulse laser (532 nm) with a sCMOS camera will be utilized for observing the collective behavior of charged DEHS oil particles. MatLab and PIVview will analyze images collected in terms of averaged velocity field and vorticity. The anticipated outcomes encompass a better understanding of the EHD flow dynamics through discharge electrode optimization to improve PM2.5 capture by electrostatic particle clustering.

9CO.1

A New Framework for Modelling Wildfire Smoke Aerosol Concentration.

DAN BARTHAUX, Andreas Zuend, *McGill University*

Wildfire smoke is a primary source of particulate matter (PM) pollution. Due to the sheer number of species emitted from a biomass-burning event, it is usually impractical to include much more than the emissions of primary organic aerosols within partitioning schemes for PM forecasts in large-scale air quality models. However, understanding the interplay of secondary organic aerosol formation and air parcel dilution at a more detailed level is of interest for improved representation of wildfire events. In this work we introduce a new framework linking multiple models to simulate the gas-phase chemistry and PM concentration within a smoke plume over time. An emission ratios dataset of detected species (ppb/ppm CO) is compiled from previous studies and used to initialize the F0AM chemical box model applied to a Lagrangian plume parcel with dilution. The HYSPLIT model is used to attain wildfire-associated parcel trajectories and associated hourly variables for the box model. The saturation vapor pressures for the several thousand generated species are then calculated from molecular structure information. The species are further represented on a 2D volatility–polarity grid and lumped into a manageable number of surrogate components. These surrogate components are then used as inputs in a thermodynamic multiphase equilibrium model based on the Aerosol Inorganic–Organic Mixtures Functional groups Activity Coefficients (AIOMFAC) model. This model enables predictions of the gas–particle partitioning from the mixture of surrogate components while accounting for changes in temperature and relative humidity along the trajectory. We discuss applications of this framework to a set of wildfire events that impacted the city of Montreal from 2010 to 2021. Measurements from the Canadian air pollution monitoring network were used both to estimate the initial concentrations of fire-emitted species as well as to compare our simulations with measured $PM_{2.5}$, ozone, and sulfur dioxide.

9CO.2

Ground Based Studies to Evaluate the Impacts of Prescribed Burning on Production of Secondary Species. RIME EL ASMAR, Rodney J. Weber, Greg Huey, M. Talat Odman, David Tanner, *Georgia Institute of Technology*

The use of prescribed burning in managing ecosystems and preventing wildfires has been increasing in the US. Prescribed burning is conducted in favorable weather and fuel conditions to ensure maintaining control of the fire. These fires may negatively affect the local and regional air quality due to emissions of particulate matter (PM) and gaseous compounds and formation of secondary pollutants. In this work, ground-based measurements of smoke from prescribed fires in southeastern US were taken during the burning seasons of 2021, 2022, and 2023 at different US military Forts that perform regular prescribed burns. Emissions of trace gases (CO, O_3, and NO_x) and particles ($PM_{2.5}$ mass, BC, and BrC) and evolution of these species were studied. Ozone levels followed typical diurnal patterns with higher concentrations of 45-50 ppb during a typical afternoon in fair weather conditions. During these periods, additional ozone enhancements (ΔO_3) were always observed in smoke impacted airmasses (range ΔO_3: 6.3-95.8 ppb), and $\Delta O_3/\Delta CO$ was found to be high in smoke of higher estimated ages for up to 6 hours, with a strong correlation of ΔO3/ΔCO with physical age of smoke (r2=0.89). In all these cases, $\Delta PM_{2.5}/\Delta CO$ increase with physical age was also observed; there was a strong correlation between $\Delta PM_{2.5}/\Delta CO$ and age (r2=0.65). In contrast, no clear trend in $\Delta PM_{2.5}/\Delta CO$ with physical age was observed for smoke without ozone enhancements including plumes measured at night. This suggests that photochemically-driven secondary aerosol formation consistently occurred only in the plumes detected in the afternoon. The aim of this study is to investigate prescribed fire emissions and smoke evolution for evaluating models used in wildland fire management, to help sustain burning while minimizing adverse effects on air quality.

9CO.3

Performance and Uncertainty of Portable Emissions Measurement Systems (PEMS) in Laboratory and On-Road Tests for Improved Quantification of Vehicle Exhaust Particles. MOHSEN KAZEMIMANESH, Jorge Saturno, Kim Winther, Rasmus Pettinen, *National Physical Laboratory*

Ultrafine particles (UFP) and gaseous pollutants emitted from vehicle exhausts are major contributors to air pollution in urban areas. UFPs are especially concerning for human health due to their deeper penetration in the lungs. In the EU, the number of solid exhaust particles larger than 23 nm is regulated for on-road type approval of vehicles by testing real driving emissions (RDE) using portable emissions measurement systems (PEMS). However, PEMS are likely to have larger measurement uncertainty due to simpler design, while metrological validation of PEMS is currently lacking. Thus, it is critical to understand this uncertainty to underpin the current and future conformity factors.

The performance and uncertainties of the PEMS devices were evaluated by setting up a test matrix consisting of both in-laboratory and RDE tests. The PEMS devices were evaluated between 2021 and 2023 with four Euro 6 emission class passenger cars and in two countries, Finland and Denmark. During this study four PEMS devices were evaluated, three commercially available PEMS devices and a 'GoldenPEMS' (which was validated metrologically by several European National Metrology Institutes, NMIs). The PEMS devices used condensation particle counting (CPC) and diffusion charging (DC) technologies for particle number (PN) measurement.

The results showed that a significant day-to-day variation exists in RDE tests, with the same vehicle, test route, and driver. Day-to-day variations are mostly larger than device-to-device variation. Measured PN can vary by more than ± 50% depending on the PN measurement system. The performance of the tested PN-PEMS analysers varied depending on vehicle type. The RDE results recorded with DC-based PEMS correlated better with laboratory results for tests producing lower PN emissions, while the CPC-based PEMS performed better for tests producing higher PN emissions. The results suggest that the two PN PEMS devices may have to be tuned for different emission matrixes.

9CO.4

Measuring Particulate Matter Emissions from Prescribed Fires across Colorado. ANNAMARIE GUTH, Marissa Dauner, Evan Coffey, Sean Benjamin, Peter Hamlington, Chad Hoffman, Michael Hannigan, *University of Colorado at Boulder*

The western US has experienced an increase in wildfire activity, contributing to increased periods of poor air quality. Drier and hotter conditions due to climate change are increasing the severity and area burned during wildfires. Wildfires release large quantities of particulate matter (PM). Exposure to PM can have many negative short and long-term health impacts. Prescribed fires are a highly effective way of reducing wildfire risk but come with tradeoffs; for example, prescribed fire still releases PM. This project uses low-cost emissions tools (EPODs) to measure PM at prescribed burns throughout Colorado. EPODs have been used previously in published studies to measure emissions from cookstoves and trash burning. The EPOD uses a Plantower sensor to measure $PM_{2.5}$ and collects PM onto a quartz fiber filter to quantify amounts of elemental carbon and organic carbon, and complete organic speciation. For each burn, we quantify $PM_{2.5}$ emissions factors using the partial capture carbon balance method and modified combustion efficiencies. The placement of each EPOD at prescribed fires is determined by BluSky Playground, an interactive model developed by the USFS to predict ground plume movement and $PM_{2.5}$ concentrations. Additionally, we began using a BLK360 terrestrial lidar scanner to take scans pre and post-burn scans at prescribed fires to quantify fuel reduction. We have partnered with several different county and forest service implementers around the state of Colorado. So far throughout this project in partnership with implementers, we have attended 10 prescribed burns, 7 pile burns, and 3 broadcast burns; burn windows for the types of burns are different which also impacts burning conditions. I will present emission factors for carbonaceous components of PM, combustion efficiency, and fuel reduction. I will discuss how these metrics and their variability are impacted by the type of prescribed fire, environmental parameters, and landscape.

9CO.5

The Organic Acids Composition of Aerosols Originating from the Canadian Wildfires in College Park, MD. ESTHER OLONIMOYO, Martin Ahn, Dewansh Rastogi, Yue Li, Akua Asa-Awuku, *University of Maryland*

Wildfires in Canada began in March 2023, intensified in June, and spread over thirteen million hectares by August 1 st , 2023. Smoke emerging from these wildfires traveled across the North American continent, as air quality alerts were issued in 20 states within the US. Its effects were visible in the College Park, Maryland, area as the air quality index (AQI) increased to very unhealthy levels. Air particles were sampled actively from the rooftop lab of the Atmospheric and Oceanic Sciences building located on the University of Maryland campus at a flow rate of 29 mL/min onto a 0.22 µm Polyvinylidene fluoride (PVDF) membrane. Daytime (9 am to 6 pm) and nighttime (6 pm to 9 am) samples were collected from the 7 th to the 9 th of June 2023. Air particles were also collected onto a PVDF membrane for a 60-hour period from the 9 th to the 12 th of June 2023. Collected membranes were kept in a petri dish below -4 °C until extraction. Membranes were extracted with 20 mL of ultra-purified water by sonication and heating to 40ºC for 1 hour, after which the solution was filtered (90 mm Whatman filter paper) and kept below -4 °C until chemical analysis. In this work, we present measurements of the organic acids determined from chemical analysis using a Bruker Maxis-II Q-TOF mass spectrometer coupled with a Waters Acquity I-Class PLUS LC system. We also explored changes in chemical composition as a result of atmospheric aging by performing Hysplit NOAA Back Trajectory analyses. Thus, this work significantly contributes information about the prevalence of organic acids in urban centers from intensifying North American wildfire events.

9CO.6

Chemical Composition and Volatility of Phenol Photooxidation Products in the Presence of NOx. DAVID PANDO, Michelia Dam, Nga Lee Ng, *Georgia Institute of Technology*

Phenol is emitted into the atmosphere by anthropogenic and biogenic thermal processes such as wildfires, prescribed fires, and combustion engines. It is efficiently oxidized by hydroxyl (OH) radical, forming gas products with increased functionality and secondary organic aerosols (SOA) after aging in the atmosphere. Phenol is often co-emitted with high concentrations of NOx (sometimes up to ppm levels), which can react with the oxidized products to form nitroaromatics or organonitrates. These products can have different light absorbing properties and vapor pressures than non-nitrogen containing products, therefore impacting radiative climate effects and SOA formation. In this study, we measure chemical composition and estimate vapor pressure of gas and particle products of this system.

Phenol photooxidation was simulated in the Georgia Tech Environmental Chamber facility. A series of instruments is connected to the chamber to measure gas and particles: FIGAERO-CIMS, SMPS, GC-FID, and NOx monitor. Our results show that nitrogen containing organic compounds (including nitroaromatics) with 6-carbon atoms make up 40-80% of total organic particle signal from FIGAERO measurements, with nitrocatechol, nitrophenol, and $C_6H_5NO_5$ as the dominant species. Increasing phenol:OH ratio and initial seed aerosol surface area increase the fraction of these compounds partitioning to the particle phase. At lower phenol:OH chemical regimes, the fraction of non-nitrogen containing oxygenated fragmentation products (C2-C5) in the gas and particle phase increases, likely owing to enhanced multigenerational chemistry facilitated by longer lived early generation products (lower condensation sink) and a higher excess of oxidant. Increasing the initial seed aerosol surface area results in the volatility of CHO species increasing in the gas phase and decreasing in the particle phase. The volatility of CHON species in the gas phase does not change with increasing initial seed aerosol surface area, however, in the particle phase, it increases as the initial seed aerosol surface area increases.

9CO.7

Carbon and Oxygen Volatility Distributions of Biomass Burning Organic Aerosols Undergoing Oxidation and Dilution. PURUSHOTTAM KUMAR, James Hurley, Nathan Kreisberg, Tianchang Xu, Braden Stump, Patricia Keady, Nga Lee Ng, Gabriel Isaacman-VanWertz, *Virginia Tech*

The volatility of aerosols is a complex parameter which is important for understanding atmospheric chemistry and improving model predictions. For this purpose, a recently developed instrument “ChemSpot” was deployed at the Georgia Wildfire Simulation Experiment (G-WISE). The ChemSpot instrument collects aerosols into a custom-designed collection and thermal desorption cell. The collected particles are then thermally desorbed and transferred to a Flame Ionization Detector (FID) and a downstream CO_2 detector. The slow thermal desorption and this combination of detectors provide volatility-resolved measurements of aerosol carbon and the estimation for oxygen content. In G-WISE, biomass-burning organic aerosols generated by burning biomass collected from 3 different ecoregions (Piedmont, Coastal Plains, and Blue Ridge) from the state of Georgia were studied under different conditions using a variety of instrumentation. Initial results from the ChemSpot data show that the majority of the particle carbon and oxygen are present in the logC* bins of 0 to 2. Changes in the volatility distributions for aerosols generated by different types of biomass will be presented (fresh and aged aerosols). Comparisons to the measurements from another collocated instrument measuring the volatility distribution of oxygen-containing species will also be discussed.

9CO.8

The Impact of Combustion Efficiency on the Chemical Composition of Particle-Bound Organics from Residential Heating with Wood and Coal.

PATRICK MARTENS, Hendryk Czech, Jürgen Orasche, Mika Ihalainen, Martin Sklorz, Olli Sippula, Ralf Zimmermann, *Desert Research Institute*

Small-scale residential heating and cooking appliances fueled with coal are important sources of air pollution in Eastern Europe and China, and consequently fine particulate matter from coal burning is a large burden to public health in these areas. Even though coal has already been recognized as a big contributor to air pollution decades ago, information on the chemical composition of particle-bound organics, beyond some frequently targeted polycyclic aromatic hydrocarbons, alkanes and selected marker species that only make up a small fraction of the organic aerosol, is scarce.

To get further insight into the chemical composition of the unresolved complex mixture, emissions of fine particulate matter from a modern, residential wood stove were sampled on filters, subsequently analyzed with a thermal-optical carbona analyzer that was interfaced with a photo-ionization time-of-flight mass spectrometer and compared to emissions from burning spruce logs in the same stove. The thermal-optical carbon analyzer was used to parametrize the volatility of the organic aerosols using the Improve_A protocol, and the mass spectrometer is used to analyze the chemical composition of the evolving gas mixture.

The chemical nature of particle-bound organic compounds from residential coal burning indicated a tendency towards stronger graphitization with higher combustion quality. It is likely that cracking reactions in the flame were more pronounced at higher combustion quality and led to the stripping of functional moieties and substituents from semi-volatile and low-volatile aromatics, increasing the similarity to the chemical composition of high-quality wood combustion emissions. The change in the chemical nature may also trigger different toxic responses due to their different bioavailability and water solubility.

9CO.10

Particulates from a Stoker Boiler Fueled by Alternative Fuels.

MADIE HOLLE, Ibrahim Al-Naiema, Claire Meyer, Elizabeth Stone, *University of Iowa*

To reduce the use of coal, local biomass and pre-consumer waste have partially or completely offset coal in the heating and cooling of the University of Iowa campus via an industrial boiler. Pre-consumer waste paper and plastic were densified into energy pellets to convert these waste streams into a usable form for energy production. This research examines the energy-based emission factors of various hazardous air pollutants, including particulate matter (PM), particulate metals, dioxins and furans, and polycyclic aromatic hydrocarbons (PAH) for coal and these alternative fuels from 2015 to present. These hazardous air pollutants can cause adverse health effects in surrounding community members, especially those with underlying health conditions, and can cause long-term environmental damage. Samples were collected using standard stack testing methods equipped with an electrostatic precipitator, a baghouse filter, and/or a sorbent injection system. Co-firing coal and miscanthus grass decreased emissions of PM, and many particulate metals compared to coal, with minor changes to PAH emissions. Co-firing coal and energy pellets increased emissions of PM, decreased nearly all metals, and increased PAHs compared to coal. Due to challenges in attaining stable co-firing conditions, this practice was suspended in favor of fueling the boiler entirely with energy pellets. When firing the boiler with 100% energy pellets, PM emissions increased compared to coal. There were both increases and decreases in emissions of metals and PAHs, suggesting variability in these emissions with pellet composition. This research demonstrates how the magnitude and composition of emissions vary from an industrial boiler as coal is offset with alternate fuels.

9CO.11

Effect of Vehicular Electrification on Air Quality in Florida.

SHREYA SAPKOTA DHAKAL, Prashant Shekhar, Haofei Yu, Marwa El-Sayed, *Embry-Riddle Aeronautical University*

Vehicular emissions from fuel-based passenger cars emit an array of gases and particles that are detrimental for human health and the environment. In that regard, electric vehicles (EVs) present a viable, sustainable solution. This study investigates the impact of electrification of passenger cars on air quality in Florida, in five major urban counties namely Miami-Dade, Duval, Hillsborough, Orange, and Leon. Between 2018 and 2022, these counties experienced a significant increase of 217.68% ± 52.11% in EV adoption, coupled with a 11.56% ± 6.23% decrease in fuel-based vehicle usage. Herein, we characterize five pollutants primarily generated from fuel-based passenger vehicles- carbon monoxide (CO), nitrogen dioxide (NO_2), particulate matter ($PM_{2.5}$ and PM_{10}), and carbon dioxide (CO_2)- over a five-year period (2018 – 2022). Hourly traffic data counts and their corresponding emissions were analyzed using the U.S. Environmental Protection Agency's (EPA) MOtor Vehicle Emission Simulator (MOVES) software using the county scale. The shift from fuel-based vehicles to EVs has led to significant reductions in emissions across the five counties. By comparing data in 2022 to 2018, average reductions of 20.93% ± 11.73%, 13.77% ± 7.44, 41.77% ± 26.42%, 42.52% ± 27.04%, and 11.99% ± 6.42% were observed for CO, CO_2, NO_2, $PM_{2.5}$, and PM_{10}, respectively. Generally, Leon County (located in northern Florida and home for the state's capital) experienced the highest reduction followed by Miami-Dade County (located in southern Florida), likely due to their high population densities. These results will be used to forecast future emissions based on recommendations from the Paris Agreement and U.S. projections for EV adoption in 2030 and 2050. This work highlights the role of vehicular electrification as a critical strategy for improving air quality at both local and regional levels during the vehicle use phase.

9IM.1

Investigating Flow Characteristics and Particle Sampling in Drone Aerodynamics: A CFD Simulation Study.

SREEKESH KOOKKAL, Suresh Dhaniyala, *Clarkson University*

Air atmospheric sampling allows for the measurement of various pollutants and contaminants present in the atmosphere, including particulate matter, gases, volatile organic compounds, and other harmful substances. Drones equipped with air quality sensors and sampling capabilities can be deployed to collect air samples, capture air quality data at different altitudes and locations, and provide valuable insights into spatial variations and localized pollution hotspots. The use of drones for air sampling presents several challenges that needs to be addressed to ensure accurate and reliable data collection. Determining the optimal flight parameters, including altitude, speed, and flight patterns, is crucial for effective air sampling.

The positioning of sensors is a critical factor in ensuring accurate sample collection during drone-based air sampling, as the drone is in constant motion and its wings rotate at high speeds near the collection spot and sensors. The understanding and consideration of the aerodynamic flow around the drone plays a crucial role in optimizing the data collection process, minimizing interference from the drone's movement, and maximizing the reliability and precision of the collected air samples. The objective of this study is to numerically investigate the aerodynamic flow characteristics around a hexacopter drone under varying test conditions such as drone velocity and blade rotation speeds. We will detail our modeling approach, the calculated performance characteristics as a function of operating conditions, and the wind-tunnel experimental validation in our presentation.

9IM.2

Bidimensional Charge Distribution of Compact and Fractal Aerosols in a Unipolar Charger. NISHAN SAPKOTA, Timothy Sipkens, Rym Mehri, Steven Rogak, Joel Corbin, *University of British Columbia*

Charging aerosols unipolarly is often an ideal choice for particle detection and signal enhancement in many aerosol applications. A good understanding of charging behavior is, therefore, necessary for interpreting the data accurately. However, measuring the charge distributions from a unipolar charger is a difficult task, especially for higher ion concentrations and larger particle sizes. As the number of elementary charges on the particles increases, the electrical mobility for adjacent charges becomes indistinguishable requiring a complicated data inversion. To further resolve it, recent studies have proposed a new analysis method, interpreting the measurement of charging efficiencies as bidimensional distributions. In this study, we apply an adaptation of this method while characterizing a unipolar charger for aerosol particle aerosols of different shapes– spheres (Santovac® polyphenyl ether), cubes (sodium chloride), lacey aggregates (soot from an inverted burner), and compact aggregates (compaction using oleic acid). Aerosols of these morphologies were conditioned and size-selected using both a differential mobility analyzer (DMA) and an Aerodynamic Aerosol Classifier (AAC), then passed through the candidate charger for final characterization using a second DMA column. The use of an AAC ensured that there were no multiply charged artifacts in the classified particles passed through the first DMA and ensured that the particles had a known mobility diameter. The unipolar charger used in this study was a diffusion charger operated with two ion concentration-time products (Nit) of 5e12 and 3e13 ion s/m3 and a fixed flow rate. Computed charge fractions agree well with previous literature and demonstrate an increase in the level of charge on fractal aggregates.

9IM.3

Development of a Low-cost Aerosol Concentrator for Bioaerosol Sampling. Francisco Romay, RYNE JUIDICI, Aaron Collins, David Y. H. Pui, *University of Minnesota*

Bioaerosols are typically present at low concentrations in the environment, making them difficult to measure at small sampling flow rates. A practical solution to this problem is to use an aerosol concentrator that increases the concentration of the particles of interest, (>1 µm).

Historically virtual impactors have relied on CNC machining due to the tight dimensional tolerances, which has resulted in high manufacturing costs, but also in design limitations due to the machining process. The reduced cost and increased availability of high-resolution stereolithography (SLA) printing, has enabled us to greatly innovate the design and manufacturing of virtual impactors. The new design for additive manufacturing enabled both the accelerating nozzle and receiving tube to be printed in a single unit at that about 1/10th of the cost of traditional machining, while still maintaining an adequate nozzle size and geometry for a sharp cutoff curve. Our design has a nominal 400:1 concentration factor, with an inlet flow rate of 120 L/min and an outlet concentrated flow rate of 0.30 L/min, with two virtual impactor stages in series operating at the same diameter cutpoint. The first stage has 20 sets of nozzles in an opposing jet configuration, leading to a second stage with a single nozzle and receiving tube. The aerosol concentrator was evaluated experimentally with highly monodisperse oleic acid particles generated by a flow-focusing monodisperse aerosol generator, followed by a multiplet reduction impactor. The experimental aerodynamic diameter cutpoint was 1.84µm with a geometric standard deviation of 1.16, which is considered a sharp separation cutoff curve. The total pressure drop of the new aerosol concentrator was 3.9 kPa at the nominal inlet flow rate. This small flow resistance allowed us to select a miniature high-speed 35W blower. The new aerosol concentrator will be used with a low-cost, induced-fluorescent bioaerosol sensor.

9IM.4

Evaluating a Cloud Chamber in Controlling Coagulation and Wall Losses at High Particle Loads. NEVIL FRANCO, Kyle Gorkowski, Katherine Benedict, *Los Alamos National Laboratory*

In events such as wildfires and explosions, high concentrations of particles rapidly coagulate at rates that are sensitive to particle shape and surface adhesion. In these concentrated plumes, assumptions based on spherical particles breakdown due to the abundance of chain-like soot particles. Los Alamos National Laboratory's new cloud chamber was designed to address the blind spot on second-order effects of coagulation in dense plumes of aerosols. Initial experiments in the 900L stainless steel chamber were conducted without humidity to characterize the particle wall loss. In these dry experiments, different types of aerosols were used to quantify the rates of deposition to the walls using a particle size and time-dependent formula fitted with data from aerosol size measuring instruments. Sodium chloride, sucrose, PSL, dust, and smoke were all introduced separately to the chamber at low and high concentrations. Preliminary results show that aerosols are lost to the walls and dilution in the chamber in relatively short time scales. This study lays the foundation for future coagulation experiments at elevated humidity and supersaturation conditions to characterize the influence of particle shape on coagulation and cloud parameters.

9IM.5

Enhanced Chamber Wall Loss of Intermediate Volatility Polar Organic Compounds at High Water Vapor Concentrations. KENNETH S. DOCHERTY, Diya Yang, Olson David, Mohammed Jaoui, Michael Lewandowski, *U.S. Environmental Protection Agency*

Results of a series of experiments conducted to investigate the role of water vapor in enhancing chamber wall loss of intermediate volatility polar organic compounds (IVPOC) are reported. Smog chamber investigation and wall loss characteristics of IVPOC are of interest, in part, due to the potential for volatile consumer products to contribute to ambient secondary organic aerosol formation. In the current study, a range of alcohols including C4-C9 linear alcohols, aromatic alcohols, and 1,2-ethanediol were used as surrogates of IVPOC and were introduced individually into the EPA continuous flow smog chamber along with propane as an internal standard. Chamber relative humidity (RH) was actively controlled in stages to vary from a minimum of ~3% to a maximum of ~40% while both inlet manifold and chamber gas phase concentrations were monitored continuously by on-line gas chromatography with flame ionization detection. Care was taken to rule out transmission losses throughout the system as the underlying cause of measurement variation. The extent of wall loss for each surrogate was calculated as the ratio of compound concentration measured from the inlet manifold upstream of the chamber to that measured from the chamber itself. Dilution ratios across the range of surrogates increase with chamber RH and the magnitude of this increase trends opposite to compound vapor pressure on average. Monitoring the decay rate of surrogate chamber concentrations under both dry and humid conditions suggests that high water vapor concentrations may also moderate the short-term reversibility of IVPOC wall losses under conditions like those here by limiting the repartition of these compounds back to the gas phase. A mechanism consistent with these observations is proposed and the implications of these results to both chamber and ambient IVPOC measurements are discussed.

9IM.6

Transmission Efficiency of Two Pumped Counterflow Virtual Impactors of the Same Kind for Cloud-aerosol Interactions Studies.

SHREYA JOSHI, Lynn Mazzoleni, Will Cantrell, Raymond Shaw, Simeon Schum, Thusitha Divisekara, Ian Helman, Gourihar Kulkarni, Timothy Onasch, Kyle Gorkowski, Arthur J. Sedlacek, Ogochukwu Enekwizu, Claudio Mazzoleni, *Michigan Technological University*

The Pumped Counterflow Virtual Impactor (PCVI) is a cost-effective and compact tool that separates large from small aerosol particles based on their momentum. Therefore, PCVIs are often used for separating droplets and non-activated aerosol particles in clouds and fog. Several previous studies utilized PCVIs to understand the interactions of aerosols with a cloud’s droplets or ice crystals. However, most studies do not report the particles’ transmission efficiencies (TE), and for those that do, the range of values is very wide going from 45% up to 95%. We report on the TE of two PCVIs of the same kind, performing comparative analysis under controlled laboratory conditions with a range of particle types and sizes including several dry aerosols, as well as cloud droplets. We found that both units performed very well for rejecting particles below the selected particle size cut (e.g. interstitial aerosol in cloud studies); however, we also found significant differences in TEs for larger particles, with variations especially pronounced under higher add flow conditions and during water droplet transmission experiments. We hypothesize that minor manufacturing differences in the PCVI units or differences in wear and tear might have substantially impacted their performances. These results underline the usefulness of PCVIs, but also emphasize the need for careful unit-specific characterization and calibration before use in field and laboratory settings to enhance the reliability of quantitative aerosol measurements and advance our understanding of aerosol-cloud interactions.

9IM.7

A Novel Automated Sampler Designed for Improved Spatiotemporal Resolution of Volatile Organic Compound Measurements.

JACKSON RYAN, Paulus Bauer, Ana Luisa Santiago O. Vilela, Alejandra Hernández-Terán, María Rebolleda-Gómez, Celia Faiola, *University of California, Irvine*

Secondary Organic Aerosols (SOA) can form through atmospheric oxidation of volatile organic compounds (VOCs) that are emitted from biogenic and anthropogenic sources. Monoterpenes (MTs) and sesquiterpenes (SQTs) are especially important because they are major emissions from terrestrial vegetation. Quantification of structural isomers is critical because different terpene isomers can vary in atmospheric reactivity by orders of magnitude and can have significantly different SOA mass yields. Therefore, even with low mixing ratios, it is possible for some MTs and SQTs to play a more important role in atmospheric chemistry processes. However, isomer-specific measurements often require extensive labor and/or specialized field instrumentation leading to challenges in adequate spatiotemporal resolution of these measurements – particularly in remote areas. This study involved building and testing a new automated cartridge sampler system that can be deployed in urban and remote environments to address this critical challenge. The sampler was designed using PFA tubing and custom PEEK manifolds to limit sampling line losses upstream of the sorbent cartridges. Additionally, the sampler is automated and can be operated using solar-charged battery-power to allow for collection of up to 12 individual samples between sample retrievals. Furthermore, the sampler was designed with 2 separate inlets connected to 6 cartridges each facilitating the ability to connect the sampling lines to two different locations or to collect 2 cartridges simultaneously for duplicate measurements.

Sampler design and proof-of-concept measurements will be presented. Preliminary testing on the sampler has been conducted, leveraging an ongoing plant-microbe interactions study at UC Irvine. Soil VOCs were measured from different treatment groups. Soil VOC composition and concentrations from the different treatment groups will be presented.

9IM.8

Improvements in Airborne Aerosol and Trace Gas Measurement Capabilities on the University of Wyoming's Next Generation King Air Research Aircraft.

ANNA ROBERTSON, Eric Beamesderfer, Matthew Burkhart, Bart Geerts, Nicholas Mahon, *University of Wyoming*

The University of Wyoming has been operating a King Air aircraft as a national public research platform for over 40 years and since then has conducted over 30 NSF-funded projects, as well as several educational and non-NSF-funded projects, with research focuses spanning from cloud remote sensing to cloud microphysics and atmospheric chemistry. The University of Wyoming King Air (UWKA) platform has been part of NSF's Lower Atmospheric Observing Facilities (LAOF) program from its inception in the late 1980s and is now part of NSF's Facilities for Atmospheric Research and Education (FARE) program. A recent Mid-scale Research Infrastructure (MSRI) grant from NSF has allowed for the acquisition and modification of a new aircraft, the next generation King Air (UWKA-2), to replace the original UWKA and continue serving the public as a research platform for many years to come.

After several years of hard work and with over 50 modifications to the airframe to support new and existing instrumentation, UWKA-2 is nearing completion. With the addition of external mounting locations and fuselage ports and the ability to support a larger payload, the new aircraft will have increased capability to support both user- and Facility-supplied instrumentation. Funding from the MSRI has also allowed our Facility to build upon our pre-existing suite of instrumentation and further improve our aerosol and trace gas measurement capabilities. This includes a MIRO 10-species Gas Analyzer, a Brechtel Isokinetic inlet for ambient aerosol sampling, and others.

This presentation will provide an overview of our existing and updated measurement capabilities, a timeline for the completion of the research platform, as well as information on how to request the aircraft for future research and educational campaigns.

9IM.9

Atmospheric Pressure Environmental (APE) Chamber for Chemical Imaging of Aerosol Samples Under Mimic Real-World Condition.

ZEZHEN CHENG, Yuzhi Chen, Alexander Smith, Andrey Liyu, Ashfiqur Rahman, Carter Bracken, Swarup China, Vimal Kumar Balasubramanian, Arunima Bhattacharjee, Nurun Nahar Lata, Qian Zhao, Alla Zelenyuk, Daniel Perea, *Pacific Northwest National Laboratory*

Aerosol particles affect climate directly by absorbing (warming effects) and scattering (cooling effects) incoming solar radiation and indirectly by acting as a seed for warm and cold clouds. Offline analysis of aerosol samples by scanning electron microscopy (SEM) is a critical tool to help improve our knowledge of aerosol's impact on climate by investigating chemical (e.g., elemental composition) and physical (e.g., size, and mixing state, ice nucleation activity, phase state, and hygroscopicity) of individual particles. However, SEM analysis has the significant caveat that the low-pressure ($\sim 2\times10^{-6}$ Torr) inside the chamber can cause a complete loss of water and volatile species during the chamber pumping stage, resulting in physical deformation from desiccation and misleading heterogeneous chemistry information. Therefore, a need exists for SEM analysis capability while samples exist under different, non-vacuum environmental conditions. Thus, an environmental (APE) chamber that can be integrated into the Environmental SEM (ESEM) chamber is built. More detail of the APE chamber will be provided in the presentation. We will present some preliminary SEM chemical imaging results of different types of aerosols (e.g., dust, secondary organic aerosol, and salt) retrieved from this novel APE chamber.

9IM.10

Validity for Detecting DPF Failure by Measuring Particle Number in Tailpipe. Kenta Hasegawa, HIROYUKI YAMADA, *Tokyo Denki University Graduate School*

Measuring particle number (PN) in tailpipe have been considered to be a useful tool to detecting failures with DPFs. This methodology has already been adopted in periodic technical inspection (PTI) process in several European countries. In this study, correlation between the test with chassis dynamo and tailpipe PN has been obtained to evaluate the validity of this methodology. In addition to that, tailpipe PN were measured in Japanese PTI stations.

9IM.11

Design and Development of Nested Inlet for Sampling Stratospheric Aerosol (NISSA) for Effective Reduction of Turbulence in Aircraft Aerosol Measurements. NAGARAJAN RADHAKRISHNAN, Sreekesh Kookkal, Suresh Dhaniyala, *Clarkson university*

The sampling of aerosol particles in the stratosphere for studying size distribution, concentration, and chemical composition often encounters challenges related to turbulence during aircraft-based measurements. This study proposes a design and development of a Nested Inlet for Sampling Stratospheric Aerosol (NISSA) aimed at mitigating turbulence effects for more accurate aerosol sampling. NISSA utilizes a nested mechanism incorporating two distinct inlet sizes to efficiently reduce turbulence during aircraft aerosol sampling. The first section of NISSA acts as a shroud and ensures that sampled flow is unaffected by the aircraft angle of attack. The second section acts to isokinetically sample flow and the reduce its speed without increasing flow turbulence. The final sample section is designed to sub-sample isokinetically from the slowed down flow and enable turning of the sample flow and bring it into the aircraft plumbing. The inlet design was partially based on previous inlet geometries, including the NCAR HIMIL inlet and the final geometry was established based on results of parametric modeling of inlet sampling performance. The parametric computational fluid dynamics (CFD) modeling of this inlet was performed using the K-omega turbulence model in ANSYS FLUENT and integrating the flow modeling results with a new turbulent particle trajectory model developed in our group. We will present final inlet design, details of inlet modeling, and predicted performance characteristics of NISSA under a range of aircraft sampling conditions in the stratosphere.

9IM.12

Exploring the Relationship Between Filter Loading Effect and Aethalometer Multiple Scattering Enhancement Factor C in an Urban Background Site. ASTA GREGORIČ, Luca Ferrero, Matic Ivančič, Irena Ježek Brecelj, Bálint Alföldy, Martin Rigler, *Aerosol d.o.o.*

An accurate determination of aerosol absorption coefficient (b_{abs}) is crucial for assessing the climate impact of light-absorbing aerosols. Filter photometers, commonly used for wide spectral range measurements (UV-IR) of b_{abs}, suffer from three key artifacts: a) multiple scattering effect due to enhanced optical path by filter fibers, b) backscattering of aerosol embedded in filter matrix, c) loading effect. While automatic loading effect compensation is integrated into Aethalometer software (using dual-spot method), the remaining two artefacts depend on filter material and aerosol optical properties and are compensated by the use of single parameter – multiple-scattering parameter C, which can be determined based on supplementary measurements of aerosol scattering coefficient [1] or by other reference measurements [2].

Recently, a novel method inferred C quantitatively based on intrinsic aerosol properties reflected in the loading compensation parameter [3]. Method provides MAAP complaint C characteristic for 660 nm.

Our study presents monthly resolved C values for a 3-year dataset, applied to calculate equivalent black carbon (eBC) and b_{abs} measured by Aethalometer AE33 (Aerosol Magee Scientific) at the urban background station in Ljubljana, Slovenia. Seasonal variations in C were observed, with lowest values (2.23) in winter and highest (3.6) in summer due to varying aerosol optical properties. The average C value (2.56 ± 0.39) closely aligns with Milan's characteristics (2.51 ± 0.04) [3] and was found to be just slightly higher than 2.45 reported for the ACTRIS sites [4].

Monthly resolved determination of C value calculated from the loading effect compensation factors provides an efficient and reliable way to correct the eBC and b_{abs} results in near real time without the need for additional measurements.

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9IM.13

Low-Cost, In-Situ Surface Tension Measurements of Hanging Aerosol Mimic Droplets under Controlled Atmospheric Conditions. BRUNO LOYOLA SAN MARTIN, Michael Haines, Tzu-An Kuan, Joseph Woo, *Lafayette College*

Hanging droplet experiments of aerosol mimic solutions are useful due to their unique combination of measurable surface phenomena on geometries approximating aerosols and working solution volumes sufficient for straightforward condensed-phase characterization (e.g. refractometry, mass spectroscopy, UV-visible absorbance) without additional processing. While the governing equations for pendant drop tensiometry are well-established, consistent control of ambient conditions around a hanging droplet can prove non-trivial to reliably implement. This work compares time-resolved surface tension measurements of aqueous aerosol mimic solutions using a pendant drop tensiometer constructed from 3D printed parts and a webcam against a research-grade profile analysis tensiometer. Measurements of hanging droplets exposed to controlled concentrations of water vapor and low-mass VOCs (e.g. ethanol, isopropanol, etc. are assessed. Scripted exposure sequences that induce multiple, scheduled step-change shifts to droplet ambient gas-phase compositions around hanging droplets are performed. Using this approach, first-order step responses to measured surface tension are observed.

9IM.14

Measuring VOCs and HOMs with a Single Instrument: Comprehensive Analysis of Complex Gas Mixtures by Multi-Pressure Chemical Ionization Mass Spectrometry.

HENNING FINKENZELLER, Aleksei Shcherbinin, Jyri Mikkilä, Jussi Kontro, Netta Vinkvist, Juha Kangasluoma, Matti P. Rissanen, *University of Helsinki*

Multiple CIMS instrument configurations, distinguished particularly regarding the IMR pressure, have been required to analyze the complex mixture of atmospherically relevant trace gases that differ regarding chemical properties and therefore require different ionization approaches. For polar, functionalized compounds, very sensitive detection schemes are provided by high-pressure adduct-forming chemical ionization techniques (e.g., NO_3^--CIMS), whereas for non-functionalized, non-polar compounds, low-pressure chemical ionization techniques (e.g., PTR) have consistently demonstrated superior performance. Here, using a MION2 chemical ionization inlet and an Orbitrap Exploris 120 mass spectrometer, we present Multi-Pressure Chemical Ionization Mass Spectrometry (MPCIMS), the combination of high- and low-pressure ionization schemes in a single instrument, enabling the quantification of trace gases across compound classes from the same unaltered gas stream. We demonstrate the performance of the new methodology in a laboratory experiment employing a-pinene, a monoterpene relevant to atmospheric particle formation, where MPCIMS allows to measure the spectrum of compounds ranging from the volatile precursor hydrocarbon to highly functionalized condensable reaction products. MPCIMS carries the potential as an all-in-one method for the analysis of complex gas mixtures, reducing technical complexities and the need for multiple instruments without compromise of sensitivity.

9IM.15

Method Optimization for the Measurement of Aerosol Particle Size Characterization from Heated Tobacco Products.

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

Heated Tobacco Products (HTP) contain a tobacco substrate heated to temperatures below 350°C, resulting in an inhalable nicotine-containing aerosol. Previously a new pressure-feedback loop sampling interface was developed to measure particle size distribution (PSD) of HTP aerosols using a low-flow rate cascade impactor which was presented at AAAR 2023. The objective of this study is to use the interface to systematically investigate the influence of experimental conditions such as the shape of puff profiles, humidity level of the dilution air, and dilution volume on the HTP aerosol particle size distribution.

The results demonstrated no significant difference in the particle size distribution and aerosol mass collected on the impactor between bell-shape and square-shape puffing profiles. The results also showed that using humid air for aerosol dilution can minimize aerosol evaporation compared to dry air and result in more accurate PSD measurements. A minimal dilution ratio with humid air of 1.21: 1 was established for measuring the mass median aerodynamic diameter of HTP aerosols. Additionally, another methodology was developed to measure emission-based PM2.5 of HTP aerosols, which is another aerosol design parameter required for regulatory submissions as per the Premarket Tobacco Product Applications (PMTAs) and Recordkeeping Requirements Final Rule issued by the Food and Drug Administration (FDA) in 2021. Potential transportation loss and sampling artifacts were evaluated to understand the measurement uncertainty associated with PM2.5 measurements. Minimal transportation loss was observed in the interface. As previously mentioned, the humidity of dilution air significantly impacted downstream aerosol mass collection, and using humidified air during sampling can minimize aerosol sampling loss. The measured PM2.5 concentrations across three HTP products were within the same order of magnitude.

9IM.16

Optimization of Liquid Level in a Condensation-based Bioaerosol Sampler for Efficient Sampling using Machine Learning. Xiaohan Li, MOHAMMAD WASHEEM, Amin Shirkhani, Matthew D. Jansen, William B. Vass, Xing He, Bian Jiang, Z. Hugh Fan, Chang-Yu Wu, *University of Miami*

The Viable Virus Aerosol Sampler (VIVAS) enlarges airborne viruses via water vapor condensation, facilitating their efficient collection in a viability-conserving liquid medium. However, reliable prediction of its performance across diverse environmental conditions remains challenging due to its highly tunable parameters. Field observations revealed that collection dish liquid levels, which significantly impact conservation of virus viability and VIVAS efficiency, fluctuate with ambient conditions and sampler settings. To address this, we propose an extendable machine learning pipeline, designed to identify optimal conditions for a specific liquid level, and reliably predict whether a given set of experimental parameters will yield acceptable outcomes. This pipeline, iteratively improvable with additional data, addresses this gap by stratifying 148 data points, into training and testing subsets with an 80/20 ratio. We utilized Python's Lazy Predict to identify optimal classification threshold for liquid levels to enhance clustering effects and select the most suitable classification algorithm. We further refined our model through hyperparameter tuning with five-fold cross-validation. As one of the top-performing ML algorithms, XGBoost achieved over 76% Macro F1 Score and identified the top three most important features for liquid levels by gain to be (1) moderator temperature, (2) particle concentration, and (3) temperature difference between moderator and nozzle. The model demonstrates reasonable performance despite the complexity of such experiments and limited data availability due to their time and effort-intensive characteristics. Also, as illustrated, the pipeline retains the flexibility to prioritize alternative metrics, thereby accommodating the specific requirements of diverse scenarios. For future work, we aim to further improve the prediction through collection of additional data and feature engineering, which is the process of transforming data into more effective forms of inputs. Additionally, the selection of primary evaluation metrics will be tailored to effectively balance the cost and return across various experimental designs.

9IM.17

Effects of Particle Phase State on the Measurement of Sea Spray Aerosol Composition Using Extractive Electrospray Ionization Mass Spectrometry. SAMANTHA KRUSE, Paul Tumminello, Alexia Moore, Christopher Lee, Kimberly Prather, Jonathan Slade, *University of California San Diego*

Extractive electrospray ionization time-of-flight mass spectrometry (EESI) is an online technique for the measurement of aerosol molecular composition, offering high time resolution and reduced sample collection times. In this work, we measure three biological marker compounds (glycerol, palmitic acid, and potassium ions) in sea spray aerosol (SSA) with EESI during a phytoplankton bloom. We show SSA composition changes based on the three marker compounds dependent on biological activity in the seawater. We also found that the EESI sensitivity is dependent on sample relative humidity independent of pressure variations and reagent ion intensity. To characterize this effect, we modeled the reagent ion's diffusive path through the sample aerosol and demonstrate that it is highly dependent on particle viscosity, which is modulated by relative humidity. These results align with recent studies which show that EESI sensitivity can be dependent on particle size and mixing state. These dependencies are also demonstrated in the results, where there is a higher sensitivity for compounds found at the particle surface. This work emphasizes the importance of particle phase state for the accurate measurement and quantification of aerosol composition using EESI.

9IM.18

Identifying Photocharring of Single Particles in an Aerosol Raman Hyperspectral Imaging Instrument. MAXWELL FREEMAN, J. Alex Huffman, *University of Denver*

Raman spectroscopy is a powerful tool for identification of aerosol particle composition, however the excitation source may induce photochemical transformations that alter the compositions–and therefore the Raman spectra–of particles under interrogation. Here we test a specific photochemical transformation, photocharring, with a previously described aerosol Raman hyperspectral imager (ARHI) that is commercially available through Battelle as the Resource Effective Bio-Identification System (REBS). The REBS is equipped with a 50 mW 638 nm LED laser which was used to interrogate mineral dusts, crystallized organic acids, particles composed of common biopolymers, and primary biological aerosol particles (PBAP). Replicate spectra from single particles and composite spectra from the replicates were evaluated to identify instances when photocharring occurred. Darker particles that absorbed more visible wavelengths of light were more likely to be photocharred than less absorptive, lighter particles.

9IM.19

Development of a Custom Aerosol Test Chamber and Stand-Off Chemical Aerosol System for Detection and Classification. STEVEN PULLINS, Meredith Melendez, David Alburty, Darren Radke, Adam Luxon, Jonathan Mueller, Garrett Wendell, Miles Egan, Seth Henshaw, Deborah Hunka, *Leidos*

Many toxic chemical threats are delivered as aerosols. Rapidly identifying these types of particles is imperative to human health and protection as well as national security. Aerosol detection and classification, particularly in complex environments, presents a challenging technical problem that cannot be understated and requires developing enhanced detection methods.

The iCATS standoff detection system is being developed under the IARPA PICARD program. The PICARD program intends to develop fieldable sensing platforms for the rapid chemical classification of aerosol particles in plumes. The development of the iCATS focuses on the following challenges: distance from the plume, low concentrations, arbitrarily shaped particles, and challenging environments.
A custom aerosol test chamber has been constructed to facilitate the iCATS sensor. The chamber has multiple aerosol particle generation technologies (both liquid and solid), particle size distribution capabilities from 1 nm–10 um, aerosol recirculation capability, and a modular interrogation path length (1–10 m).

The iCATS sensor performs active longwave infrared (LWIR) spectral measurements of chemical aerosol cloud optical extinction using a scattering surface at up to 10 meters standoff. The sensor design extends laser spectroscopy used for gases to chemical aerosols while removing the need for a retroreflector. This approach takes advantage of the method’s high sensitivity and specificity. We use quantum cascade lasers (QCLs) covering the LWIR (800–1250 cm^{-1}) spectral range. The laser is operated in pulsed mode to achieve the power level needed to measure a return signal from a diffuse surface, and detection is AC coupled to suppress environmental thermal infrared signals.

Collecting the reflected signal from a diffuse surface allows for the use of “surfaces of opportunity” enabling collection in real-world scenarios. Advanced AI/ML algorithms are trained to extract the aerosol signatures from the raw data that may include added spectral features from the reflected surface.

9IM.20

Trace Aerosol Signature Detection and Classification Using Standoff Quantum Cascade Laser Absorption Spectroscopy: Preliminary Forward Modeling Results from the IARPA PICARD Program. MILES EGAN, Justin Maughan, Seth Henshaw, Jonathan Mueller, Adam Luxon, Vanessa Lynch, Steven Pullins, Garrett Wendell, David Alburty, Darren Radke, Meredith Melendez, Deborah Hunka, *Leidos*

Aerosol sensing platforms are required to mitigate hazards to human health and society, yet fieldable, trace aerosol sensing platforms remain elusive due to the complicated nature of aerosol phenomenology, namely that aerosol extinction spectra vary as a function of aerosol particle shape and size, aerosol analog variety, and aerosol conglomeration with ambient particles such as dust, pollen, bacteria or water. Complicating matters further, aerosols present dangers in trace concentrations, in dynamic, complex environments where more luminous, ambient sources compete against aerosol signatures for dynamic range of a sensing platform.

The IARPA PICARD program was stood up to develop fieldable sensing platforms for rapid standoff detection of harmful aerosols beyond the current state-of-the-art. In this work, we present our solution to the above problem set, specifically the design, build, and modeling of a state-of-the-art bistatic, quantum cascade laser absorption spectrometer capable of aerosol detection and classification by measurement of aerosol extinction spectra after reflection from a surface of opportunity. We call this new sensing platform the intelligent Chemical Aerosol Transmission Spectrometer (iCATS).

To support this effort, we developed rigorous, physics-based forward modeling tools for the iCATS sensing platform to model sensor subsystem performance, predict synthetic extinction spectra, calculate large libraries of synthetic extinction spectra for training detection and classification algorithms, and define detection limits as a function of optical design choices, sensing geometry, and aerosol phenomenology. We present the need for aerosol remote sensing in the CBD S&T community, how the iCATS sensing platform addresses that need, how we use forward modeling tools to emulate sensing data products and train models, how closely forward modeling predictions match experimental measurements collected with the iCATS prototype, and make predictions about what aerosols will be detectable at the end of the program.

9IM.21

A Wide Range, Multi-Angle, Light Scattering Device to Probe Hazardous Aerosol Particles. RAIYA EBINI, Joshua Hubbard, Christopher M. Sorensen, Alex Brown, Joseph Zigmond, *Sandia National Laboratories*

In past work, a unique combustion chamber was designed to capture soot from small liquid and solid waste fires designed to mimic nuclear waste [1],[2]. It was found that the mass of hazardous contaminants released was not directly proportional to the mass of the material consumed by fire [1],[2]. The size and morphology of these particles are important factors in respiratory health assessments. Our goal is to provide in-situ, real-time, characterization of aerosols that contain hazardous contaminants. We have built a wide range, multi-angle, light scattering device to accomplish this goal. The optical design adopted here is primarily influenced by the design of Guatum and Sorensen [3]. Our new apparatus can probe three separate scattering regimes: forward, back, and side scattering. Combining these regimes is important to provide a complete understanding of scattering by aerosol particles [4].

In preliminary experiments we integrated the combustion chamber with a small angle light scattering apparatus. This allowed us to characterize the forward scattering regime. Soot aggregates released from burning kerosene, and other contaminated flammable mixtures, were characterized. Soot aggregates were investigated within the luminous flame as well as after it left the chamber as smoke. The size of soot aggregates within the flame was 0.5µm whereas in the smoke it was 7.5µm.

Our new, four detector apparatus is designed to accomplish the following goals: simultaneously probe the three scattering regimes, study soot aggregates inside and outside the flame simultaneously, and accommodate hazardous materials like depleted uranium. This poster shows the design and calibration for this device. The apparatus contains two forward scattering detectors designed to probe the soot inside and outside the flame. Each scattering regime has a designated detector. Calibration methods have been developed and are outlined here.

SNL is managed and operated by NTESS under DOE NNSA contract DE-NA0003525.

9IM.22

Comparison of Physics-Based and Machine Learning Based Approach for Calibration of Low-cost Particulate Matter Sensors.

Brijal Prajapati, MANORANJAN SAHU, Chandra Venkataraman, Pratim Biswas, *Indian Institute of Technology Bombay*

Low cost particulate matter sensors are receiving significant attention as they can be used in large number for spatial and temporal measurement of PM mass and number concentration. However, the data reliability is questionable as these sensors are affected by numerous parameters such as temperature, relative humidity, and hygroscopicity of particles. To ensure accurate and reliable measurement of particulate matter concentrations, performance evaluation and calibration of LCS co-located with reference instrument at site is essential. In this study, the performance of the low-cost sensor (APT Maxima) was evaluated with the reference instrument SASS (Speciation Air Sampling System) sampler for developing suitable calibration factor that include impact of the meteorological parameter such as relative humidity and temperature, and hygroscopicity. In this study, we have demonstrated a systematic physics-based method for calibration of LCS based on κ-Köhler theory and Mie theory. For comparison with statistical models, linear regression and machine learning algorithm were also applied. In physics-based model, calculated total light scattered intensity shows good linearity with reference PM2.5 measurements. Physics based model performed better for both the sites as compared to MLR, kNN, RF, and GB ML algorithms with R2, RMSE, and MAE values of 0.72,18.21, and 13.36 for Bhopal site, and 0.91, 7.84, and 5.76 for Kashmir site, respectively. Study indicates that physics-based approach for LCS calibration is suitable and can be transferable to different sites.

Keywords: Low-cost sensor, Physics-based model, Sensor calibration

Acknowledgements: This work was supported by the Ministry of Environment, Forest and Climate Change (MoEF&CC), Government of India, under the NCAP-COALESCE project {Grant No.14/10/2014-CC (Vol.II)}.

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9IP.1

New Particle Formation Driven by 222 nm Germicidal Ultraviolet Light.

MATTHEW GOSS, Jesse Kroll, *MIT*

Germicidal ultraviolet lamps with a peak emission at 222 nm (GUV_{222}) are effective at reducing the airborne spread of pathogens, but recent studies have identified these lamps as a source of ozone and additional secondary pollutants such as secondary organic aerosol (SOA). While ozone production from 222 nm light is now relatively well-quantified, SOA formation under GUV_{222} conditions has received less study. This study compares SOA formation from limonene under GUV_{222} irradiation (which involves UV photons as well as secondary ozone), or in the presence of ozone only (with no UV radiation), to distinguish the role of photolytic processes versus purely ozone-driven chemistry in aerosol formation. This work takes place in a large chamber (7.5 m^3, used for SOA yield measurements) and a small chamber (0.15 m^3, used to study nucleation and compositional differences). Additional experiments investigate particle formation in outdoor air sampled into the small chamber, and explore the influence of NO_2 and HONO, both relevant indoor air pollutants. We consistently observe far more new particle formation under high-fluence-rate GUV_{222} conditions (45 $\mu W\ cm^{-2}$) than when O_3-only conditions are used. Despite clear differences in nucleation, aerosol yield and composition differ only slightly between GUV_{222} and O_3-only conditions. While most observations are well-explained by traditional ozone chemistry, new particle formation is clearly enhanced by direct or indirect photolysis processes, and represents an additional reason to employ GUV_{222} only at the lowest effective levels.

9IP.2

Detection of and Protection from Extreme VOC "Spikes" Generated during Everyday Cooking, Cleaning, and Artistic Activities. Sonam Devabhaktuni, Sathyaraj Devabhaktuni, DEVABHAKTUNI SRIKRISHNA, *Patient Knowhow, Inc.*

Prior work characterized extreme levels of VOC generation during cooking such as when frying oils/fats. However, using low-cost TVOC counters we discovered extremely high levels of VOC generated ("spikes") during everyday cooking, cleaning, artistic activities in a duration-dependent and distance-dependent manner. These activities included toasting bread, opening bags of pastries, peeling oranges fruits, opening chocolate ice cream containers, cleaners / disinfectants, opening alcohol containers, and alcohol-based markers. The spikes observed came as a surprise to many which were liked and shared on Twitter (https://twitter.com/sri_srikrishna/status/1668840882613948416) . Whereas spikes were not detected during some other common cooking and artistic activities. In many instances, ventilation using outside air reduces these spikes but most models of home air cleaners (filtration) tested even with carbon included were insufficient to rapidly clear up VOC spikes during the activity. Only two models of home air cleaners (filtration) which included several pounds of activated carbon were able to predictably reduce VOC with measurable air changes per hour (ACH). In this research, we present a test matrix of TVOC measurements of spikes observed during a range of everyday cooking activities using both a more expensive and lower-cost VOC monitors, nearby and at a distance, in presence of different levels of air cleaning (with ventilation with fan connected to open window, VOC air filtration). Given the unpredictability of spikes based on the activity, duration, and distance these results motivate wider use of low-cost VOC counters 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) VOC air cleaning for indoor occupants at a distance, and if air cleaning of indoor VOC is inadequate, personal protection such as P100 elastomeric respirators with organic vapor cartridges to protect those with direct exposure to VOC spikes at close range.

9IP.3

High Efficacy of Grignard Pure(TM), a Triethylene Glycol-Based Material, in Neutralizing Airborne Microbial Agents. Grishma Desai, Jamie Balarashti, Gurumurthy Ramachandran, Emanuel Goldman, William Jordan, Etienne Grignard, GEDIMINAS MAINELIS, *Rutgers, The State University of New Jersey*

The COVID-19 pandemic highlighted the critical role of airborne transmission in spreading infectious diseases, particularly in indoor environments. Historical research from the 1940s and 50s indicated the potential of triethylene glycol (TEG) as an effective agent against airborne pathogens. Subsequently, comprehensive safety assessments have demonstrated TEG's negligible toxicity when used appropriately. Grignard Pure™, an antimicrobial product developed for easy airborne dispersion, uses TEG as its active ingredient. Our earlier work showed that low concentrations of airborne Grignard Pure™ (0.04 mg/m^3 to 0.5 mg/m^3) can inactivate 2-3 logs of airborne MS2 virus, used as a surrogate for airborne viral pathogens. We extend our initial work and present efficacy of Grignard Pure™ against an array of other airborne microbial agents that are also used as surrogates for pathogenic microorganisms: gram-positive bacteria Staphylococcus epidermidis and Listeria innocua, gram-negative bacteria Klebsiella aerogenes and Salmonella typhimurium, bacteriophage Phi6, mycobacteria Mycobacterium smegmatis, and even hardy mold spores Aspergillus brasiliensis. We show that Grignard Pure™, when dispersed, can inactivate 99-99.9% (net 2-3 logs) of airborne non-mold organisms within 30 min. Even hardy mold spores were inactivated with an efficacy of 96% (net log of 1.4) within 30 min. By contrast, when the same microorganisms were treated with Grignard Pure™ in liquid form (as opposed to airborne dispersion), inactivation was substantially lower. Our findings not only demonstrate high potential of Grignard Pure™ as an effective and safe air treatment but also emphasize the importance of appropriate testing protocols. Specifically, results of surface inactivation testing with a liquid agent cannot be directly extrapolated to airborne efficacy of the same antimicrobial agent. Overall, the use of TEG-based products, such as Grignard Pure™, would enhance our toolkit for treating air in indoor spaces, thereby potentially minimizing the transmission of infectious diseases and future pandemics.

9IP.4

Indoor Air Quality Information to Optimize Ventilation Parameters. CHETHANI ATHUKORALA, Suresh Dhaniyala, *Clarkson University*

Ventilation systems help maintain thermal comfort and healthy indoor air quality by controlling outdoor air rate, using in-line filters and additionally incorporating air cleaning methods. Often, the ventilation systems are not sophisticated enough to satisfy both the necessary comfort and indoor air quality levels. Often, indoor air quality is not even measured, so our inability to maintain indoor air is not even captured. In this study, we monitored air quality, energy, thermal parameters in a heavily-used lecture room in Clarkson University over a period of two years to understand the interplay between these parameters and determine the optimal pathway to achieve necessary indoor conditions while minimizing energy use. The monitoring suite included research-grade instruments such as Aerodynamic Particle Sizer (APS), Condensation Particle Counter (CPC), and Ultra-High Sensitivity Aerosol Spectrometer (UHSAS) and a network of low-cost TelosAir sensors that measured particulate matter, CO_2, VOCs, temperature, and relative humidity. Four sensors were located around the room and four sensors were placed in the ventilation system to monitor outdoor air line, return air line, and supply air line. We analyzed the data to determine the relation between ventilation system operation, outdoor air conditions, indoor space usage, and resultant indoor air quality. Using a data-driven Machine learning model to drive the ventilation system, we demonstrate that we can achieve both indoor air and thermal comfort goals while reducing energy use relative to the baseline, manual system. We will present our air quality monitoring approach and the obtained results and discuss the optimization pathway for ventilation system operation that we determined.

9RM.2

Real-Time Monitoring and Sampling of Alpine Black and Brown Carbon from the Colorado Rockies. STEVEN SHARPE, Catalina Botero-Carrizosa, Felipe Rivera-Adorno, Jay Tomlin, Nurun Nahar Lata, Zezhen Cheng, Erik Hulm, Swarup China, Ryan Moffet, Alexander Laskin, *Purdue University*

Snowpack in the Colorado Rockies is a crucial source of fresh water, 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 (LAP), primarily black carbon (BC), brown carbon (BrC), and mineral dust (MD). LAP in snowpack decreases its albedo and accelerates spring snowmelt. We deployed a Magee Scientific AE33 aethalometer for real-time monitoring and sampling of BC and BrC from spring 2022 until fall 2023 and a Time-Resolve Aerosol Collector (TRAC) during the summer of 2023 as part of the Surface-Atmosphere Integrated Field Laboratory (SAIL) campaign. Aethalometer optical data was analyzed with K-means clustering algorithm to identify key events for filter tape analysis with Direct Analysis in Real Time (DART) high resolution mass spectrometry aided with temperature programed desorption (TPD) to assess the relationship between the optical and chemical properties and Chemical Imaging (CI) analysis from TRAC samples. Events include smoke plumes from the 2023 Canadian wildfire and a series of local emissions from nearby campfires. Correlating optical, CI, and HRMS data will improve particle resolved models that account for individual particle complexity in alpine environments.

9RM.3

Observations of New Particle Formation and Growth in the Sonoran Desert. KRISTEN CRAMER, Alex Guenther, James Smith, *Univerisity of California, Irvine*

Desert environments comprise one-third of the land area on Earth, but little is known about the source of aerosol particles in the desert. To address this need for a more comprehensive view of atmospheric new particle formation, we measured ultrafine particle size distributions in the Sonoran desert near the town of Borrego Springs, CA. Size distribution measurements were performed during a 16-month period (1/2018 – 4/2019), and were supplemented by an analysis of volatile organic compounds (VOC) on September 8, 2018. Seasonally averaged growth rates ranged from 2.7 nm/hr in the winter to 5.5 nm/hr in the summer, with a maximum observed growth rate of 9.9 nm/hr. Particle formation event frequency also peaked in the summer months, with the appearance of sub-20 nm diameter particles occurring on 29% of days and regional small particle growth events occurring on 49% of days. The Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model was used to calculate back trajectories for the summer, and showed influxes in air from the San Diego and Los Angeles air basins, which correlates with increased ozone at the site. VOC measurements featured no isoprene, while monoterpenes and sesquiterpenes dominated at concentrations similar to those measured in some forested regions. The lack of isoprene, which suppresses the formation of C20 dimers of monoterpene oxidation products, suggests that unique particle formation mechanisms dominated by monoterpene chemistry may occur in the Sonoran desert. These findings further our understanding of anthropogenic pollutants impacting remote environments and demonstrate the need for further study of atmospheric composition in the southern California desert bioregion.

9RM.4

Survey of Accumulation Mode Particulate Halogens (I, Br, Cl) over the Remote Atmosphere. DONGWOOK KIM, Pedro Campuzano-Jost, Benjamin A. Nault, Douglas A. Day, Michael Cubison, Jack Dibb, Yuk Chun Chan, Lyatt Jaegle, Thomas Ryerson, Alessandro Franchin, Eric Apel, Rebecca Hornbrook, Alan Hills, Donald Blake, Lee Mauldin, Yandong Tong, Rainer M. Volkamer, Jose-Luis Jimenez, *University of Colorado, Boulder*

Halogens play important roles in ozone chemistry in both the stratosphere and troposphere. Bromine can affect the deposition rate of mercury in the atmosphere. Particulate halogens can react directly with ozone and could serve as reservoirs for gas-phase reactive halogen species. However, quantitative measurements of particulate halogens on a global scale over remote areas are rare, especially in the upper troposphere and the lower stratosphere. Here we report particulate halogen measurements (iodine, bromine, chloride, and perchlorate) with a customized University of Colorado high-resolution aerosol mass spectrometer (CU-HR-AMS) from multiple aircraft campaigns, including the NASA ATom missions and the NSF TI^{3}GER campaign. In this study, we present a global overview of particulate halogen distribution over the remote atmosphere. We also discuss 1) AMS response to particulate halogens and quantification method, 2) particulate halogen measurement intercomparison, and 3) episodes of the enhancements of iodine and perchlorate near the tropopause and their implications for ozone chemistry in the stratosphere. These results will provide valuable constraints on the halogen budget and chemistry in chemical transport models.

9RM.5

Regional Distributions of Atmospheric Emission, Concentration, and Deposition of Particulate Elements in the Canadian Athabasca Oil Sands Region. LEIMING ZHANG, Abdulla Al Mamun, Irene Cheng, Fuquan Yang, Xin Qiu, *Environment and Climate Change Canada*

To assess potential impacts of particulate elements associated with mining activities in Athabasca oil sands region (AOSR) in northern Alberta, Canada on human and ecosystem health, regional scale distributions of atmospheric emission, concentration, and deposition of major and trace elements need to be quantified. An emission inventory for 29 elements was first developed based on PM2.5 and PM2.5-10 emissions distributions in AOSR and USEPA SPECIATE database, which was then used as input in the CALPUFF dispersion modeling to simulate ambient concentration distributions, covering an area of approximately 300 by 420 km2 in AOSR. Modeled concentrations were evaluated using field measurements collected at three monitoring sites to ensure the reasonable accuracy of the developed emission inventory. The model simulated ambient concentrations were further bias-corrected against measured concentrations and then combined with separately modeled dry deposition velocities, forecasted precipitation rates, and literature values of element-specific fine mode fractions and scavenging ratios by rain and snow to generate regional scale atmospheric dry and wet deposition amounts. The emission database was further split into three sub-categories for fine elements and two sub-categories for coarse elements to assess the direct impact of oil sands emissions on the ambient levels and atmospheric deposition of particulate elements through model sensitivity tests. Annual mean total deposition (mg/m2/year) of all elements was 717 in Zone 1 (within 30 km from the reference point, representing the center of the industrial facilities), 115 in Zone 2 (30-100 km from the reference point), and 35.4 in Zone 3 (beyond 100 km from the reference point). Emissions related to oil sands mining activities were responsible for 78% and 68% of the sum of the mean ambient concentrations of all elements in PM2.5 and PM2.5-10, respectively, and for ~74% of the total atmospheric deposition of all elements.

9RM.6

Global Simulations of Phase State and Equilibration Timescales of Secondary Organic Aerosols with GEOS-Chem. REGINA LUU, Meredith Schervish, Nicole June, Samuel O'Donnell, Shantanu Jathar, Jeffrey R. Pierce, Manabu Shiraiwa, *University of California, Irvine*

The phase state of secondary organic aerosols (SOA) can be liquid, amorphous semi-solid, or glassy solid, which is important to consider as it influences various multiphase processes including SOA partitioning, size distribution dynamics, heterogeneous chemistry as well as cloud condensation and ice nucleation. Most chemical transport models typically employ instantaneous equilibrium partitioning for SOA formation by implicitly assuming that SOA adopts a low viscous liquid phase state. In this study we simulate the glass transition temperatures (T_g) of SOA species and particle viscosities over the globe using the global chemical transport model, GEOS-Chem. The simulated spatial distributions show that SOA at the surface exists as liquid over equatorial regions, solid at the mid-latitude continental regions with low RH, and semisolid over the remaining lands. In the free troposphere, the predicted frequency of semisolid and solid particles becomes much greater than that of liquid particles. Using the derived bulk diffusivities, we simulate spatial distributions of the effective mass accommodation coefficient (α_{eff}). We also calculate equilibration timescales (τeq) with the KM-GAP model which considers gas and bulk diffusion of oxidation products into the particle phase. Our results show that SOA particles over Western US, northern Africa, and Western China do not equilibrate within the chemical time step of GEOS-Chem of 20 min with α_{eff} less than 0.1; hence, kinetically limited non-equilibrium growth would need to be considered for these regions in future large-scale model studies. The addition of an SOA phase state prediction scheme and the change to SOA partitioning could impact the predicted aerosol evolution in the atmosphere and its projected impacts on air quality and climate.

9RM.7

Aerosol Characterization in the Arctic Region during Cold Air Outbreaks. LINTONG CAI, Sunandan Mahant, Emma Weissburg, Anna Robertson, Jefferson Snider, Markus Petters, *University of California, Riverside*

Cold air outbreaks (CAOs) over the Norwegian and Greenland Seas are characterized by pronounced air-sea energy exchanges. During CAOs, the fluxes are a consequence of the sea surface temperature being larger than the air temperature. The temperature gradient fosters the formation of convective marine boundary layer clouds, often accompanied by precipitation and occasionally the formation of polar lows. The Cold-Air Outbreak Experiment in the Sub-Arctic Region (CAESAR) involved the NSF/NCAR C-130 aircraft in research flights across the open waters spanning northern Sweden to the Arctic ice edge, and offered a comprehensive perspective on CAOs by deploying a suite of airborne remote sensors, aerosol, cloud, precipitation, and trace gas probes. Here we describe the fields of the particle size distributions, estimated PM2.5 mass concentration, and black carbon size distributions and mixing state from the aerosol probes deployed during CAESAR. Our findings show surprisingly large spatial and temporal variability in the flight domain, including surprisingly large concentrations of black carbon aerosol over the sea ice. The data is used to evaluate aerosol composition fields simulated by the Goddard Earth Observing System composition forecast . Data-model comparison shows reasonable agreement between simulated and observed aerosol fields. These measurements yield valuable insights into aerosol-cloud interactions over the Norwegian and Greenland Seas and serve to enhance the validation of weather forecasts and climate models.

9RM.8

Quantifying Sulfur and Bioaerosol Emissions from Sargassum Strandings in South Florida. SHAHAR TSAMERET, Nohhyeon Kwak, Brittany Mc Intyre, Rivka Reiner, Helena Solo-Gabriele, Jiayu Li, *University of Miami*

The impacts of marine biota on atmospheric aerosols are key to understanding the climate and environmental impacts of aerosols. Recently, an addition to this field of study has been found in Sargassum, a genus of macroalgae that originates in the Atlantic and deposits onshore (stranding) in coastal areas. Sargassum provides habitat for bacteria, including those producing volatile sulfur compounds (VSCs), which are known to play a role in aerosol processes, and affect human health. While it is known that Sargassum emits VSCs, its emissions are not well quantified. We aim to provide measurements and emission factors of key VSCs from Sargassum, including hydrogen sulfide, sulfur dioxide, dimethyl sulfide, and dimethyl disulfide. Additionally, we aim to classify bioaerosols produced from Sargassum strandings. We conducted field measurements at a beach in South Florida for 2 summers (2023 and 2024), collecting bioaerosols with BioSamplers, aerosol size distribution with a GRIMM optical particle counter, and analyzing VSC concentrations with Teledyne sulfur analyzers. To supplement the field data, we recently initiated a chamber study quantifying VSC emissions from Sargassum over time, and continuously measuring bioaerosols from Sargassum microcosms with a BioSpot-VIVAS. During the first year of field sampling, no measurable Sargassum stranded at the study site. During the second year, strandings have been observed and are continuing to occur. Preliminary results from the second year show total sulfur (TS) concentrations averaging 32.1 ppbv when there is minimal stranding. The chamber study's preliminary results indicate continued emissions at the ppb level over multiple months of decomposition. At the conclusion of this summer's campaigns, we will present a study of Sargassum emissions and their relationships with environmental factors in the field. Our findings will be used to quantify the impacts of Sargassum strandings on coastal air quality.

9RM.9

A Comprehensive Study of Particulate Matter (PM) in the Environmental Justice (EJ) Community of Eastern Coachella Valley (ECV): Status Update and Preliminary Results.

JOSEPH SALAZAR, Yumeng Cui, Julia Montoya-Aguilera, Christopher Lim, Mohammad Sowlat, 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. Previously, we presented an overview of the study design as well as the methods/instruments used for time-integrated and time-resolved characterization of dust/PM. In this presentation, we provide an update on the implementation status, and provide 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. This will be achieved through a source apportionment study leveraging both time-integrated and continuous speciated measurements. 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).

9RM.10

Comparison of Aerosol Measurements from ASCENT Yellowstone Site with IMPROVE Data.

YINGJIE SHEN, Shane Murphy, Elena Goodspeed, Roya Bahreini, Ann M. Dillner, Armistead G. Russell, Nga Lee Ng, *University of Wyoming*

Aerosol, especially $PM_{2.5}$, plays a critical role in global climate, and has a significant impact on human health. To investigate the sources, chemical and physical properties of aerosol, 12 Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT) sites were created across the US in 2023. The sites conduct a high time-resolution and long-term measurement of aerosol physical and chemical properties with an Aerosol Chemical Speciation Monitor (ACSM), Xact-625i, Aethalometer (AE33), and Scanning Mobility Particle Sizer (SMPS). In this presentation, we will compare the PM2.5 composition measured at the ASCENT Yellowstone site with the filter-based Interagency Monitoring of Protected Visual Environments (IMPROVE) network. The soil calculated based on the IMPROVE protocols using the Xact elements will also be compared and presented. The comparison among the ASCENT ACSM total mass, SMPS mass, and IMPROVE $PM_{2.5}$ suggests that submicron dust is an important factor at the Yellowstone site. Strong correlation and agreement between ASCENT calculated total $PM_{2.5}$ and IMPROVE filter-based $PM_{2.5}$ provides initial validation of the ASCENT Yellowstone measurements.

9RM.11

Sensitivity of Chemical-Transport Model Simulations of Wildfire Smoke to Fire Emission Inventories. KRUTHIKA KUMAR, Soroush Neyestani, Rawad Saleh, *University of Georgia*

We investigated the sensitivity of wildfire carbonaceous aerosol (CA) burdens over the U.S. predicted by the Weather and Research Forecasting Model Coupled with Chemistry (WRF-Chem) model to choice of fire emission inventory. We performed simulations for the month of August 2015, which featured extensive wildfires in the Northwestern U.S., and implemented two emission inventories: 1) the Fire INventory from NCAR (FINN) and 2) the National Emission Inventory (NEI).

FINN predicted larger total burned area than NEI (5,280 km^2 versus 4,480 km^2), as well as higher emissions (in gigatonnes) of CO (49,500 versus 34,700), black carbon (BC) (349 versus 264), organic carbon (OC) (3,231 versus 1,285), and total volatile organic compounds (VOCs) (15,080 versus 6,410). In addition to differences in absolute emissions, FINN and NEI had substantially different emission profiles that led to wide differences in the relative burdens of the CA and gaseous species. For the wildfires included in this study, NEI had OC:BC = 4.87 and VOCs:CO = 0.18, while FINN had OC:BC = 9.25 and VOCs:CO = 0.3. The larger emission factors of VOCs in FINN compared to NEI led to a factor 2.5 higher secondary organic aerosol (SOA) burden predicted by the simulation the FINN simulation compared to NEI. Furthermore, the differences in plume rise treatment between FINN and NEI led to discrepancies in transport and spatial distribution of the emitted species. For example, despite the higher emission rate of BC in FINN compared to NEI, the NEI simulation predicted higher average surface concentration of wildfire BC in the Northwestern U.S. compared to the FINN simulation, whereas the FINN simulation had higher overall BC burden and more prominent long-range transport. Overall, these results highlight the importance of improving the accuracy of emission inventories to better assess the impact of wildfires on atmospheric chemistry and air quality.

9SA.2

Assessing the Value of Each Instrumented CMAQ Model for Addressing Aerosol-related Policy Questions. SHANNON CAPPS, Jiachen Liu, Sergey Napelenok, Benjamin Murphy, Kirk Baker, Daven Henze, Armistead G. Russell, *Drexel University*

The Community Multiscale Air Quality (CMAQ) model has been augmented with sensitivity analysis and tracer approaches that assist policymakers in selecting optimal strategies for mitigating airborne particulate matter. Existing methods include the higher-order direct decoupled method (CMAQ-HDDM), the integrated source apportionment method (CMAQ-ISAM), the adjoint method (CMAQ-adjoint), and the newly developed hyperdual-step method (CMAQ-hyd). Each method is based on a unique mathematical approach, which shapes the questions most appropriately addressed by each. The CMAQ-adjoint is designed to efficiently answer questions about the spatially-varying emissions that influence a single concentration-based metric throughout a selected spatial and temporal domain while CMAQ-HDDM and CMAQ-hyd more efficiently quantify the varying temporal and spatial relative changes in pollutants due to a single set of emissions changes within a reasonable range. CMAQ-ISAM is better suited to quantify the entire contribution of selected emissions sources to resultant concentrations.

Our study is designed to demonstrate the value of each of these techniques to scientists and policy makers by applying them to understand emissions influences on ozone and particulate matter. Additionally, comparing the development and maintenance complexity along with computational efficiency will provide insight to those developing instrumented approaches for other CTMs and maintaining those in CMAQ.

10AC.1

Drivers of Perfluorocarboxylic Acid (PFCA) Gas-Particle Partitioning: Modeled Properties and Observational Constraints.

TREVOR VANDENBOER, Mayré Rodriguez Ramirez, Eric Vanhauwaert, Nasrin Dashti, Yashar Ebrahimi-Iranpour, Jessica Clouthier, Shira Joudan, Ye Tao, RenXi Ye, Cora Young, *York University*

The atmospheric fate of perfluorocarboxylic acids (PFCAs) is attracting increasing attention due to the role of the atmosphere in global transport of these hazardous chemicals. There is a gap in our understanding of their gas-particle partitioning, limited by available measurements, and accurate partitioning properties. We model phase partitioning of C2-C14 PFCAs in the atmosphere including deprotonation and phase partitioning equilibria among air, aerosol liquid water, and particulate water-insoluble organic matter using a range of model-derived PFCA properties. Water and organic matter content are systematically varied across a full range of atmospheric conditions. Except during severe organic matter pollution episodes, shorter-chain PFCAs are predicted to mainly partition between air and aqueous phases, while for C12 and longer PFCAs, organic matter becomes the dominant particle phase sink. The partitioning framework underestimates the particle fraction of C2-C8 PFCAs compared with several ambient observations, with discrepancies increasing for longer-chain PFCAs. One to three orders of magnitudes higher particle/gas equilibrium ratios are required to fulfill the agreement. The discrepancy could result from externally mixed dust components, non-ideality of aerosol liquid water, and missed interactions between organic matter and charged PFCA molecules. Alternatively, time integrated high-volume sampling or inadequate recognition of their acidic properties could result in sampling error and/or bias. High time resolution and selective measurements of ambient PFCAs are needed to improve environmental fate modeling of ambient PFCAs and the new technique of AIM-IC-MS capable of measuring the gas and particle phases simultaneously on hourly timescales will be presented.

10AC.2

Evaporation-Induced Transformations in Volatile Chemical Product-Derived Secondary Organic Aerosols: Browning Effects and Alterations in Oxidative Reactivity.

LIYUAN ZHOU, Zhancong Liang, Yiming Qin, Chak K. Chan, *King Abdullah University of Science and Technology*

Volatile chemical products (VCPs) are increasingly recognized as a significant source of volatile organic compound (VOC) emissions in urban atmospheres, potentially serving as key anthropogenic precursors for secondary organic aerosol (SOA) formation. This study investigates the formation of VCP-derived SOA and its physicochemical property changes. Specifically, we examine the effect of aerosol evaporation on the molecular composition, mass absorption coefficient, and reactive oxygen species (ROS) generation in SOA produced through ozonolysis of a representative room deodorant air freshener. Upon aerosol evaporation through a diffusion dryer, the solutes become highly concentrated, accelerating reactions between them. Consequently, VCP SOA exhibited a marked 42% reduction in peroxide content along with a noticeable browning, indicating significant physicochemical transformations. These transformations predominantly occurred at moderate relative humidity (RH) levels around 40% during the reduction from 80%, rather than at lower RHs (12-20%), suggesting the crucial role of aerosol liquid water in facilitating these chemical reactions. Molecular characterization revealed that evaporating VCP SOA produces several highly conjugated nitrogen-containing products, possibly through interactions between carbonyl compounds, either pre-existing in VCP SOA or transformed from peroxides during evaporation, and reduced nitrogen species in the aerosol phase. These compounds likely serve as chromophores responsible for the observed brownish coloration of the sample. In addition, we used heterogeneous oxidation of sulfur dioxide (SO2) as a probe of the reactivity of VCP SOA, which showed enhanced photochemical sulfate production upon drying, hinting at underlying enhanced photosensitization chemistry. Direct measurements of reactive species, including singlet oxygen (1O2), superoxide (O2•-), and hydroxyl radicals (•OH) showed higher abundances in dried VCP SOA samples than in undried samples when exposed to light. Our study underscores the crucial impact of drying on transforming the physicochemical properties of VCP-derived SOA, affecting the global atmospheric radiative balance and modifying its chemical dynamics in the atmosphere.

10AC.3

Chemical Characterization of Photochemical Aging of Ship Particulate Matter Emissions - Determination of Marker Compounds and PAH Decay Rates. SANDRA PIEL, Nadine Gawlitta, Deeksha Shukla, Ellen-Iva Rosewig, Hendryk Czech, Jürgen Schnelle-Kreis, Thorsten Streibel, Johannes Passig, Helena Osterholz, Jan Hovorka, Thomas Adam, Uwe Etzien, Bert Buchholz, Mika Ihalainen, Olli Sippula, Thomas Gröger, et al., Ralf Zimmermann, *Mass Spectrometry Centre;Rostock University/Helmholtz Munich*

Emissions from ships contribute significantly to the release of aerosols into the environment and have adverse effects on climate, marine ecosystems, and health. During atmospheric transport, aerosol emissions from ship traffic undergo chemical transformations involving oxidative gas-to-particle conversion and complex multiphase chemistry (“atmospheric aging”). As ship traffic mainly occurs distant to populated regions, aged aerosols may be of greater relevance for public health.

Within the ULTRHAS project (ULtrafine particles from Transportation – Health Assessment of Sources), fresh emissions from a 1-cylinder 4-stroke marine engine on a test bench, running on heavy fuel oil (0.5 % sulfur) or marine gas oil (0.1 % sulfur), were aged in the Photochemical Emission Aging flow tube Reactor (PEAR) to an equivalent photochemical age of 2 to 7 days. Filter samples of particulate matter were analyzed by comprehensive two-dimensional gas chromatography coupled with high-resolution time-of-flight mass spectrometry. The statistical evaluation based on Fisher ratios (ChromaTOF Tile) revealed the substances most affected by aging, categorized into those experiencing decay (e.g., all classes of hydrocarbons), those increasing (e.g., oxygenated classes and pyridines), and those showing intermediate peaking (e.g., furanones and long-chain acids). This allows a distinct clustering of the fresh, short, and long-term aged emissions in the principal component analysis. Furthermore, the study includes the quantification and determination of decay rates for individual polycyclic aromatic hydrocarbons (PAHs). Consequently, aging altered the PAH pattern, thus aggravating PAH-based source apportionment and the use of diagnostic ratios.

Overall, the study describes in unprecedented detail the molecular characterization of simulated photochemically aged ship emissions. The findings not only enhance the understanding of atmospheric processes but provide valuable insights for real-world emissions by tentatively identifying marker compounds for short- and long-term aging. In further studies, these results will complement toxicological data and be compared to real-world emissions from the Baltic Sea.

10AC.4

Elucidating the Mechanism on the Transition-Metal Ion-Synergetic-Catalyzed Oxidation of SO2 with Implications for Sulfate Formation in Beijing Haze. GEHUI WANG, *East China Normal University*

Currently, atmospheric sulfate aerosols cannot be predicted reliably by numerical models, because the pathways and kinetics of sulfate formation are unclear. Here, we investigated systematically the synergetic catalyzing role of transition metal ions (TMIs, Fe^{3+}/Mn^{2+}) in the oxidation of SO_2 by O_2 on aerosols using chamber experiments. Our results showed that the synergetic effect of TMIs is critically dependent on aerosol pH due to the solubility of Fe(III) species sensitive to the aqueous phase acidity, which is effective only under pH<3 conditions. The sulfate formation rate on aerosols is two orders of magnitude larger than that in bulk solution and increases significantly on smaller aerosols, suggesting that such a synergetic catalyzed oxidation occurs on the aerosol surface. The kinetic reaction rate can be described as $R=k^* [H^+]^{-2.95} [Mn(II)][Fe(III)][S(IV)]$ ($pH \leq 3.0$). We found that TMIs-synergetic-catalyzed oxidation is the dominant pathway of sulfate formation in Beijing when haze particles are very acidic, while heterogeneous oxidation of SO_2 by NO_2 is the most important one when haze particles are weakly acidic. Our work for the first time clarified the role and kinetics of TMIs-synergetic-catalyzed oxidation of SO_2 by O_2 in haze periods, which can be parameterized into models for future study on sulfate formation.

10AC.5

Sulfate Formation in Incense Burning Particles: A Single-Particle Mass Spectrometric Study. ZHANCONG LIANG, Liyuan Zhou, Rosemarie Ann Infante Cuevas, Xinyue Li, Chunlei Cheng, Mei Li, Rongzhi Tang, Ruifeng Zhang, Patrick Kwan Ho Lee, Alvin Chi Keung Lai, Chak K. Chan, *King Abdullah University of Science and Technology*

Incense burning, a common form of the residential biomass burnings, emits substantial amounts of particles. These particles are subject to atmospheric aging upon exposure to sunlight and other pollutants. In this work, we observed sulfate formation in fresh incense particles upon exposure to SO_2, using a single-particle aerosol mass spectrometer (SPAMS). The analysis of the positive mass spectra classified the particles as K-type and OC-type. In both dark and light experiments, SO_2 uptake and oxidation were found preferentially in OC-type particles over K-type particles. Sulfate formation, as represented by the number fraction of sulfate-containing particles (FS), was likely due to gaseous oxidants under dark. FS increased with UV, mainly attributable to photosensitization reactions. While more sulfate formed at higher relative humidities (RH) under dark, sulfate formation under light was independent of RH. The increase in FS due to photochemistry was more effective under lower RH, where the photoactive compounds were more concentrated and likely generated more photo-oxidants. This effect outweighed that due to reduced SO_2 dissolution. Our findings shed light on the potential of biomass burning particles to trigger sulfate formation, at a single-particle level.

10AC.6

Characteristics and Relevance of Method-defined Condensable Particulate Matter Formation from Major Stationary Sources. PAUL VAN ROOY, Dave Nash, Jason Dewees, Peter Kariher, Walter Lin, Ned Shappley, *US EPA*

In the atmosphere, condensable particulate matter (CPM) forms when stack exhaust cools and dilutes resulting in organic and inorganic gasses quickly reacting to form particulate and/or 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 and is therefore very relevant to human health for fenceline communities. EPA’s Method 202 (40 CFR Part 51, Appendix M), an impinger-based CPM measurement method, is the agency’s existing recommended methodology for state, local, and tribal agencies to use for measuring CPM. However, stakeholders have raised concerns over potential measurement bias. Dilution-based methods, like Other Test Method 37 (OTM-37) have also been used to estimate CPM mass. However, studies showing the repeatability and actionability of OTM-37, attributes paramount for a compliance method, are lacking. Both methods provide users with method-defined CPM mass. The relationship between the two methods is unknown and there are questions regarding the relevance of method-defined CPM mass to real-world, near-stack CPM formation. While this relationship is not necessary for compliance, it is paramount for understanding local and regional air quality issues and determining the most effective paths for reducing PM. For the past several years, EPA has been conducting laboratory experiments using initial conditions relevant to stack emissions to investigate the formation of CPM in the Method 202 and OTM-37 sampling trains. While results from these studies provide insight into the chemistry and variability of CPM formation within each respective sampling train, the studies lack a connection to real-world CPM formation. This work highlights the importance of developing an atmospherically relevant CPM formation method and establishes the need for a better understanding of near-stack PM formation, possibly via coupling in-stack measurements with in-plume measurements.

10CA.1

Model Framework for the Evolving Shape of Compacting Soot Aggregates. PAYTON BEELER, Joel Corbin, Laura Fierce, *Pacific Northwest National Laboratory*

Black carbon (BC) particles formed via combustion processes are emitted as fractal aggregates. Condensation of co-emitted species onto the surface of BC aggregates soon after emission can lead to restructuring of the aggregates into more compact shapes. Compaction of BC aggregates impacts their optical properties and could subsequently affect the overall radiative impact of BC. Several laboratory studies have measured the evolving shape of BC aggregates as coatings are applied to the BC surface. However, the results of these studies cannot be easily incorporated into chemical transport and Earth system models, which largely assume that BC particles exist as spheres. The most recent attempts to account for BC compaction rely on a threshold coating amount, beyond which BC particles are considered spherical. These approaches do not account for the continuously evolving shape of BC aggregates throughout the entire coating process. Here, we combine data from laboratory measurements of BC compaction with bottom-up simulations of BC aggregation to develop an empirical model that predicts the collapse of BC aggregates given their composition and initial size. The empirical model approximately reproduces the measured trends of BC compaction as a function of coating-to-BC volume ratio and number of primary particles in the aggregate and additionally predicts the fractal dimension of BC aggregates, an important input for BC optics models. The developed framework provides a continuous and differentiable relationship that connects particle size and composition to the shape of both the overall particle and the BC core. Incorporation of our results into future versions of chemical transport and Earth system models will allow for approximation of BC particle shape given properties already tracked in these models.

10CA.2

Soot Restructuring in Condensation-Evaporation Cycles. ALEXEI KHALIZOV, Ali Hasani, Egor Demidov, *New Jersey Institute of Technology*

Atmospheric soot is made of fractal aggregates of loosely connected graphitic spherules. These aggregates can undergo condensation-evaporation cycles with various atmospheric vapors, modifying the composition of aggregates and inducing their compaction. Because of these compositional and morphological changes, climate impacts of soot become significantly altered. Which leg of the condensation-evaporation cycle contributes the most to soot compaction is still not fully understood. Thus, we investigated soot restructuring at every stage of the cycle, starting with capillary condensation, proceeding toward full encapsulation, and ending with the condensate evaporation off a fully encapsulated aggregate. In our experiments, airborne fractal aggregates were exposed to vapors of wetting and non-wetting liquids, and particle mobility diameter was measured before and after coating evaporation. Additionally, these processed soot aggregates were collected on silicon wafer chips before and after condensate loss, and their morphology was examined by scanning electron microscopy. Depositing encapsulated soot particles on the surface allowed to ‘freeze’ their morphology and obtain images of structures corresponding to their encapsulated state. The experiments show that wetting and non-wetting liquids behave differently towards restructuring of bare hydrophobic soot. With wetting liquids (e.g., oxidized organics or sulfuric acid), compaction begins already during vapor condensation, producing partially restructured aggregates, but coating evaporation is needed achieve a fully restructured aggregate. With non-wetting liquids (water), there is almost no restructuring during vapor condensation, and full compaction occurs during shell evaporation. Interestingly, priming the hydrophobic soot aggregates with 1-2 mass percent of a water-soluble chemical, results in nearly full restructuring of the aggregates already during water condensation. We conclude that for wetting liquids restructuring takes place during condensation, but when non-wetting water condenses on hydrophobic soot aggregates at very high supersaturations, the aggregates remain fractal until the water shells evaporate. This finding has an important implication for evaluating the direct contribution to climate forcing by aged soot because the fractal and compact encapsulated soot aggregates differ significantly in their ability to scatter light.

10CA.3

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

Light-absorbing aerosols, including black carbon (BC) containing particles, affect Earth's radiation budget through interactions with sunlight and influencing cloud formation and their properties. Aerosols facilitate cloud formation by acting as cloud condensation nuclei (CCN) or ice-nucleating particles. However, not all clouds precipitate; they can evaporate, reintroducing the aerosols into the atmosphere, where they may undergo further interactions with clouds. Such interactions can alter the properties of these particles in the atmosphere. Cloud chamber studies provide an opportunity to investigate the effects of BC-cloud interactions in controlled laboratory settings. The Light-Absorbing Aerosol-Cloud Interactions (LAACI) project, utilizing Michigan Tech's turbulent cloud Pi-chamber, was designed to study these interactions. Utilizing surrogates for BC (cab-o-jet) and the coating material (liquid smoke), we developed a procedure to produce coated BC-like particles, which underwent cloud interactions in the Pi-chamber. We studied three particle types: (1) uncoated BC, (2) BC coated with liquid smoke, and (3) liquid smoke particles alone. Using a pumped counterflow virtual impactor, we isolated cloud droplets and dried them, giving us cloud droplet residuals, while unactivated aerosols (i.e., interstitials) were collected using a separate horizontal aerosol line. We studied the evolution of the aerosol morphological, optical, and CCN properties for the different particle types within a laboratory-generated cloud by analyzing residuals and interstitials. Notably, a significant fraction of the coated BC residuals exhibited lower solidity than the injected particles, indicating a complex interaction between morphology and aerosol activation. We also saw a decrease in the retrieved real part of the refractive index in the residual particles and an increase in the mean size of the particle distribution. This research provides insights into the atmospheric aging of BC-containing particles and their impacts on climate and should help develop more accurate parametrizations for future atmospheric models.

10CA.4

Reconciling Measured and Modeled Optical Properties of Black Carbon. OGOCHUKWU ENEKWIZU, Egor Demidov, Arthur J. Sedlacek, Ernie R. Lewis, Alexei Khalizov, *Brookhaven National Laboratory*

The optical properties of black carbon (BC) are fundamental to the radiative forcing estimations of aerosols in climate models. These properties depend on the sizes and morphologies of the individual BC particles. Despite advances in numerical predictions of BC properties, there are still differences between measured and modeled optical parameters of fresh BC particles. The mass absorption cross-section (MAC; m^2/g) and single scattering albedo (SSA) of BC particles are underestimated by advanced numerical methods for computing BC optical properties, such as the Multiple Sphere T-Matrix (MSTM) and Discrete Dipole Approximation (DDA), which explicitly consider the morphology of BC particles. This discrepancy results from fundamentally incorrect or oversimplified assumptions about the morphological features of fresh BC particles, which are frequently found as uncoated, branched aggregates that are comprised of 10 to 50 nm diameter carbon spheres (monomers). Optical simulation studies of morphologically realistic BC particles often assume a constant monomer diameter for different BC particle sizes whereas multiple experimental observations have shown a direct correlation between monomer diameter and BC particle mobility diameter. Another assumption is that of point-touch contacts between monomers comprising the BC aggregate. Field observations have shown that BC aggregates are often made of overlapping monomers with necking (smooth transition contact area) between neighboring monomers. We assess the effects of variable monomer diameter and necking on the determination of the MAC and SSA for numerically generated BC particles of different sizes. We use MSTM calculations to account for the different monomer diameters and DDA calculations to account for the necking between monomers. We found that using variable monomer diameters yielded more realistic SSA values, and the inclusion of continuous necking between monomers in the BC particles reduced the difference between measured and modeled MAC values.

10CA.5

Optical Properties of Laboratory-Synthesized Dark Brown Carbon Tar Balls.

SHU-WEN YOU, Prabhav Upadhyay, Zezhen Cheng, Guodong Ren, Taveen Kapoor, Joseph V. Puthussery, Benjamin Sumlin, Swarup China, Rohan Mishra, Rajan K. Chakrabarty, *Washington University in St. Louis*

Tar balls (TBs) are a subset of brown carbon (BrC) aerosol generated from combustion sources and contribute to approximately 30% of atmospheric biomass burning (BB) aerosol mass. Understanding the interplay between TB's formation mechanisms, physicochemical properties, and optical properties is crucial to predicting their climatic effects. Dark BrC (d-BrC) TBs, which were reported during FIREX-AQ, have properties similar to black carbon, i.e., they strongly absorb light, are insoluble in organic solvents, and are resistant to photobleaching. However, few studies have systematically investigated the fundamental properties of d-BrC TBs, partially due to their unclear formation mechanisms. In this study, we generated d-BrC TBs using tar-containing condensate from the dry distillation of apple wood. The condensate was filtered, diluted with pure methanol, aerosolized, and then passed through a thermodenuder (for a heat shock environment similar to that in wildfires) at temperatures of 250, 300, 350, and 400 °C to generate TBs with a range of optical properties. D-BrC TBs were generated at higher heat shock temperatures, with the complex refractive indexes obtained from scanning transmission electron microscopy coupled with electron energy loss spectroscopy (STEM-EELS). The imaginary refractive index ranged from 0.24 to 0.32 at 550 nm, similar to those observed in the FIREX-AQ field campaign. The aerosol ensemble single scattering albedo of d-BrC TBs, as reported by custom-built integrated photoacoustic nephelometers (IPNs), ranged from 0.37 to 0.42 at 375 nm and from 0.48 to 0.50 at 721 nm. In addition, the d-BrC TBs were collected for further analyses, including morphology, volatility distribution, and functional group characterization with scanning transmission X-ray microscopy (STXM). We report the fundamental properties of laboratory-synthesized d-BrC TBs, which not only advance our understanding of their potential formation mechanisms but also our capability to produce d-BrC TBs for future studies.

10CA.6

Molecular Insights into Gas-Particle Partitioning and Viscosity of Atmospheric Brown Carbon.

Qiaorong Xie, Nealan Gerrebos, Diego Calderon-Arrieta, Isaac Morton, Emily Halpern, Chunlin Li, Janice Zeng, Yinon Rudich, Allan K. Bertram, ALEXANDER LASKIN, *Purdue University*

Biomass burning organic aerosol (BBOA), containing numerous brown carbon (BrC) compounds, exerts a notable influence on atmospheric chemistry and radiative forcing of climate. The influence of evaporation processes on optical properties, volatility, and viscosity of BBOA under different environmental conditions remains poorly understood, leading to uncertainties in predicting the atmospheric and climate effects of BrC. This study presents a molecular characterization of laboratory BBOA proxies analyzed at various stages of evaporation, labeled as PO_x (where x represents the initial to remaining volume ratio after evaporation). The molecular characterization results are then applied for a bottom-up assessment of the volatilities and viscosities of the analyzed mixtures. The individual compound saturation mass concentration values measured using temperature programmed desorption – direct analysis in real time – high resolution mass spectrometry are used to construct volatility basic set (VBS) distributions. These distributions quantify the extent of gas-particle partitioning, revealing more compounds transition from the particle phase to the gas phase with atmospheric dilution. Conversely, atmospheric cooling enhances condensation of the gas-phase compounds into the particle phase, underscoring their sensitivity to both temperature and atmospheric dilution. Furthermore, the VBS-based assessment of gas-particle partitioning is leveraged to estimate the viscosities of BBOA represented by PO_x. These estimates align closely with viscosity values obtained through poke-flow experiments, thus validating the estimation approach. As the degree of evaporation increases, the viscosities of PO_x mixtures exhibit a substantial increase, resulting in a substantial slowdown in particle-phase diffusion. This new understanding emphasizes the critical role of evaporation processes and environmental conditions in transforming the volatility and viscosity of BBOA particles. These factors should be adequately integrated into atmospheric transport models for improved accuracy in predicting BBOA aging transformations.

10CE.1

Production, Processes, and Parameters for Secondary Organic Aerosol from Oxygenated Volatile Organic Compounds Found in Volatile Chemical Products. Huiying Luo, Masoud Akbarzadeh, Abraham Dearden, Jamie Cast, Amel Ksaibati, Alison Piasecki, Ann M. Middlebrook, Lauren A. Garofalo, Delphine K. Farmer, Katelyn Rediger, Matthew Coggon, Carsten Warneke, Cort Zang, Tucker Melles, Audrey Lawrence, Megan Willis, Chelsea Stockwell, Lu Xu, Damien Ketcherside, Lu Tan, Lixu Jin, Lu Hu, Rebecca Schwantes, SHANTANU JATHAR, et al., *Colorado State University*

With limited laboratory studies and current knowledge, Secondary organic aerosol (SOA) production from oxygenated volatile organic compounds (OVOCs) is inadequately represented in atmospheric models. In response, the Secondary organic aerosol Chamber Experiments on Non-Traditional Species (SCENTS) initiative conducted a set of 27 experiments in a 10 m3 environmental chamber at Colorado State University to study the oxidation chemistry of 14 diverse Volatile Chemical Products (VCP) OVOCs under atmospherically relevant conditions, with additional sensitivity tests on carbitol, benzyl alcohol, furan, and furfural. In this work, we analyzed and modeled the measurements using the Statistical Oxidation Model (SOM)-TwO Moment Aerosol Sectional (TOMAS) model to understand the influence of carbon and oxygen numbers, functional moieties, NOx levels, and relative humidity on SOA mass yields. Consistent with previous works, benzyl alcohol exhibited rapid and substantial SOA production with mass yields up to 100% under high NOx conditions. Furfural oxidation led to high SOA mass yields (up to 27%), with approximately half formed via aqueous pathways. Peak SOA mass yields for furan and carbitol were both around 10%. While dipropylene glycol methyl ether and dipropylene glycol butyl ether were not as efficient in forming SOA compared to other glycol ethers (carbitol, butyl carbitol). Additionally, linalool, α-terpineol, texanol, D4 siloxane, butyl acetate, dipropylene glycol, and ethyl cyanoacrylate formed little to no SOA. As a result, volatility basis set (VBS) parameters, employed in numerous chemical mechanisms to model SOA formation and organic aerosol evolution, have been developed for these compounds. To understand the impact of NOx levels and relative humidity on SOA, we are also probing the SOA composition by examining differences in the aerosol mass spectra. This study serves to advance future quantification of SOA contribution from both anthropogenic and natural sources of OVOCs.

10CE.2

Impact of Glycol Ether Structure on OH-Initiated Oxidation and Resulting Aerosol Formation. TUCKER MELLES, Audrey Lawrence, Cort Zang, Abraham Dearden, Katelyn Rediger, Huiying Luo, Masoud Akbarzadeh, Amel Ksaibati, Damien Ketcherside, Lu Tan, Matthew Coggon, Chelsea Stockwell, Lu Xu, Ann M. Middlebrook, Alison Piasecki, Lauren A. Garofalo, Carsten Warneke, Lu Hu, Delphine K. Farmer, Shantanu Jathar, Megan Willis, *Colorado State University*

Glycol ethers are a class of volatile organic compounds (VOCs) emitted from volatile chemical products (VCPs), which are contributors to secondary organic aerosol (SOA) in urban environments. Glycol ethers are used in dyes, resins, and cleaning products and are estimated to account for 1-2% of VCP VOC emissions in California. Reported SOA mass yields range from < 0.1% to over 30%, motivating investigation into how molecular structure and environmental conditions (e.g., HO_2 and NO concentrations) impact SOA formation from glycol ether oxidation. We present results from the Secondary organic aerosol Chamber Experiments on Non-Traditional Species (SCENTS) project examining SOA formation from OH-initiated glycol ether oxidation. We use online mass spectrometry to monitor gas and particle phase composition. In our experiments, linear glycol ethers display higher SOA mass yields than branched glycol ethers of similar carbon number. We combine our observations, literature, and previously reported structure-activity relationships to construct oxidation mechanisms for both linear and branched glycol ethers. We find that the glycol ether oxygen-containing functional groups, together with the presence of branched structures, control oxidation-induced carbon-carbon bond scission. Glycol ether RO_2 fate dictates SOA production, with hydroperoxide production (via RO_2 + HO_2) promoted by our chamber conditions significantly contributing to SOA mass. Conversely, RO_2 + NO reactions generate fragmentation-prone RO radicals because ether and hydroxyl groups in glycol ethers drive carbon-carbon bond scission independent of structure. Instead, differences in SOA mass yield with glycol ether structure likely arise from available RO_2 reaction pathways. Reaction of ether-adjacent RO_2 with HO_2 may produce carbonyls or hydroperoxides; however, the carbonyl pathway is not available to tertiary-RO_2, potentially increasing the competitiveness of RO_2 + NO reactions that promote fragmentation. Glycol ether RO_2 fate and SOA production depend on molecular structure and bimolecular reactant concentrations, with branching structures and NO promoting carbon-carbon scission and reducing SOA mass yields.

10CE.3

Investigating SOA Formation from Volatile Methyl Siloxanes.

HANALEI LEWINE, Jeewani Meepage, Saeideh Mohammadi, Carlos Gutierrez, Charles Stanier, Elizabeth Stone, Eleanor Browne, *University of Colorado Boulder & CIRES*

Volatile methyl siloxanes (VMS) are anthropogenic organosilicon molecules that are used in numerous applications including in personal care products. Approximately 90% of the decamethylcyclopentasiloxane (D5) in cosmetics is released to the atmosphere. This source is believed to be one of the most important sources for D5 in both indoor and outdoor environments. VMS have recently been identified as precursors to aerosol in urban areas. The dominant D5 oxidation product, 1-hydroxynonamethylcyclopentasiloxane (siloxanol), in which one methyl group is replaced by a hydroxyl group, has been observed in lab and ambient aerosol, however absorptive partitioning alone cannot explain the amounts measured. Previous lab studies of D5 oxidation and SOA formation found a wide range of SOA yields as a function of OH exposure. Improving our understanding of SOA formation from D5 requires further investigation of the mechanism, influence of seed aerosol, and consideration of wall effects. Here, we performed chamber experiments under carefully controlled conditions such that RO2 primarily reacted with HO2, conditions which are likely to be important in the ambient atmosphere given the several-day lifetime of D5. In these experiments we investigated how the presence of seed aerosols impacts D5 SOA formation and if multigenerational chemistry is required for D5 SOA. We measured the gas phase products of D5 oxidation using chemical ionization mass spectrometry, measured particle size distribution, and characterized particulate and semi-volatile products by liquid chromatography mass spectrometry. We find that at lower OH exposures, with only one generation of oxidation chemistry, we still make SOA in the presence of ammonium sulfate seed aerosol . The major product observed in both the gas phase and the aerosol is the siloxanol. We use a kinetic box model of D5 oxidation and SOA formation to investigate the mechanism and predict SOA yields.

10CE.4

Temperature and Age-Dependent Secondary Aerosol Precursor Emissions from Building Materials and Consumer Products and Their Dynamics in Urban Aerosol.

EMILY FRANKLIN, Rose K Rossell, Cameron Osburn, Katelyn Rediger, Adam De Groodt, Michael Vermeuel, Trey Maddaleno, Dylan Millet, Allen Goldstein, Delphine K. Farmer, *CSIRO Environment*

Secondary organic aerosol formed from the condensation and oxidation of gas-phase precursors dominates fine aerosol globally, playing an integral role in the climate system and contributing to adverse health outcomes in polluted regions. Anthropogenic sources of aerosol precursor emissions have shifted away from industrial and vehicular dominance as engineering controls and regulations have evolved, increasing the relative importance of less well characterized sources broadly categorized as volatile chemical products (VCPs). This work presents the preliminary results of a series of laboratory experiments examining secondary aerosol precursor emissions from consumer products and building materials across a range of relevant parameters including temperature, age, and real-world use scenarios. Product classes examined include personal care products, cleaning products, lumber, paint, and roof tar. These results are then compared to the speciated composition of aerosol samples (analysed by two-dimensional gas chromatography) collected under ambient urban conditions as part of the Fluxes of Reactive Organic Gases in New York (FROG-NY) field campaign, which took place from early July to mid-August 2023 at a cell tower in Mineola, New York. Of the > 900 compounds speciated and traced, > 200 were classified as likely originating from VCPs, and >100 of these were positively identifiable and attributable to a plausible VCP production or use cases. These compounds include a range of species commonly reported in the gas phase or in indoor environments but rarely reported in aerosol under ambient conditions, such as phthalates, siloxanes, and coatings. Ambient atmospheric variabilities were extremely complex, but key species were elevated under conditions of low wind speeds and airmasses which passed over densely populated areas, while temperature was only weekly associated with elevated aerosol-phase concentrations. Together, these laboratory and field observations advance our mechanistic understanding of VCPs' potential contributions to secondary aerosol formation in the urban atmosphere.

10CE.5

Secondary Organic Aerosol Formation Potential of Consumer Products Used Indoors. SOFIE SCHWINK, Tony Hao, Maximilian Schmid, Marina Vance, *University of Colorado Boulder*

When volatile chemical products (VCPs) volatilize, leave the indoor environment, and enter the oxidative outdoor environment, they can undergo a complex series of oxidation reactions in the gas phase until their volatility is sufficiently low for them to condense onto particles, forming secondary organic aerosol (SOA). SOA causes adverse health effects, contributes to haze in urban areas, and affects the global climate balance and radiative forcing. We are assessing the SOA formation potential of different product categories typically used indoors, such as personal care products and cleaning products, in controlled chamber experiments. For these experiments, the product of interest is introduced into a 0.68 m^3 stainless steel chamber by passing air through a second, small chamber containing an open dish with a small volume of the product inside. The oxidation chamber contains a high concentration of ozone, which reacts with VOCs emitted from each product to form SOA. We use a scanning mobility particle sizer (SMPS) to determine particle size distributions and concentrations and an aerosol particle mass analyzer (APM) to determine the effective density of particles. SOA formation potential is calculated as a ratio of particle mass formed in the chamber to mass of liquid product evaporated. We are primarily measuring SOA formation via heterogeneous nucleation using ammonium sulfate seed but are also investigating yields from homogeneous nucleation. Understanding differences in the aerosol formation potential of common indoor consumer products could help inform us about their potential environmental impacts.

10CE.6

Application of the Hyperdual-step Method in the Community Multiscale Air Quality Model (CMAQ) for the Assessment of Aerosol Formation from Volatile Chemical Products (VCPs). JIACHEN LIU, Shannon Capps, *Drexel University*

The Community Multiscale Air Quality (CMAQ) model is a chemical transport model utilized to study the physicochemical processes in the atmosphere using meteorology and emissions as inputs. CMAQ has helped researchers and policymakers to comprehend the complexities associated with aerosol formation processes. In policy-related scenarios, the first- and second-order partial derivatives of output variables, such as criteria pollutant concentrations, with respect to input variables, such as emissions, are often of interest to ascertain expected changes due to emissions control strategies. Several methods have been employed to address this challenge, such as the higher-order direct decoupled method (CMAQ-HDDM) and the adjoint method (CMAQ-adjoint). We recently developed a novel, augmented version of CMAQ (CMAQ-hyd) capable of computing numerically exact first- and second-order sensitivities of all modeled species concentrations with respect to select emissions. The EPA developed new emissions profiles to account for emissions from VCPs (Seltzer et al., 2021). We exploit the new emissions profiles and employ CMAQ-hyd to calculate sensitivities and evaluate the health impacts of VCP-related aerosol formation across the continental United States. This study demonstrates the novel application of the hyperdual-step method in CMAQ to enhance our understanding of aerosol formation from VCPs and the potential of the novel model being applied to answer other critical policy-related questions.

10IP.1

Ozone and Secondary Organic Aerosol Production from a 222 nm Germicidal Lamp in the Presence of Scrubbers.

NADIA TAHSINI, Matthew Goss, Seamus Frey, Selena Zhang, M. Pang, Richard Williamson, Jesse Kroll, *MIT*

Far-UVC light (222 nm) has received much attention recently for its germicidal properties, as it can inactivate airborne pathogens while being safe for human exposure. However, using 222 nm lamps can generate ozone and OH in the indoor environment, which in turn can lead to the oxidation of VOCs and the formation of SOA. This chemistry affects indoor air quality and has prompted concerns related to the indoor use of 222 nm lamps. Air cleaners (“scrubbers”) pose a promising opportunity to counteract the negative effects of 222 nm lamps by removing the harmful byproducts produced by the light: for example, catalytic ozone scrubbers can remove ozone from the air, activated-charcoal-based scrubbers can remove VOCs, and filters can remove particles. In this work, we present a set of experiments carried out using scrubbers in tandem with a 222 nm lamp. Experiments are run both with and without the presence of limonene, a key indoor VOC. Results include analysis of gas-phase data from an ozone monitor and chemical ionization mass spectrometer, as well as particle-phase data from an aerosol mass spectrometer and scanning mobility particle sizer. This study provides insight into the extent to which indoor air pollution from 222 nm light can be mitigated through the use of air cleaning technology, thereby maximizing its potential benefit for human health.

10IP.2

Large-scale Evaluation of Additive Air Cleaning Effects by Filtration and Ionization Against Infectious Aerosols.

KATHERINE RATLIFF, Lukas Oudejans, M. Worth Calfee, John Archer, Marc Carpenter, Jerome Gilberry, Robert Yaga, William Schoppman, *U.S. Environmental Protection Agency*

The COVID-19 pandemic has raised interest in technologies that are intended to reduce concentrations of infectious aerosols, which can potentially reduce the risk of disease transmission and improve overall indoor air quality, through either pathogen capture or inactivation. It has proven challenging, however, to predict how well these technologies will work against bioaerosols in real-world settings. Laboratory testing is often conducted at a small scale and under optimal conditions for technology performance, and technologies are largely tested in isolation, even when they are expected to operate in tandem as part of a larger system. This poster will provide an overview of methods and results from tests conducted with both an ionization device and a MERV13 filter by the U.S. Environmental Protection Agency in a large bioaerosol test chamber with the bacteriophage MS2 as a surrogate for human viral pathogens. Testing was conducted with both technologies operating in isolation and together. Although a clean air delivery rate (CADR) can be calculated for each technology operating alone, the data suggest that these CADRs are not always additive when the technologies are operating simultaneously. These results are important for informing standardized test methods for air cleaning technologies, as well as for their use under emerging indoor air quality guidance and targets (e.g., the Centers for Disease Control and Prevention’s ventilation guidance and ASHRAE Standard 241, *Control of Infectious Aerosols*), and for optimizing performance in applied settings.

10IP.3

In-situ Effectiveness of Portable and Central Air Cleaners. RAFSAN NAHIAN, Jeffrey Siegel, *University of Toronto*

Portable and central air cleaners are commonly tested with standardized laboratory protocols. However, the laboratory-tested performance values may not accurately reflect real-world performance since the effectiveness of air cleaners can be influenced by the variation of indoor and outdoor sources, room volume and mixing, and background loss rates of pollutants. This study evaluates the in-situ effectiveness of air cleaners to capture the actual performance and uses low-cost sensors. Each experiment was conducted between one to two weeks period alternating between placebo and air cleaner active operation and the effectiveness was calculated by comparing the $PM_{2.5}$ concentrations during adjoining placebo and air cleaner operating conditions. The results indicate that the effectiveness of air cleaners is not static but varies considerably within the same environment due to the variation of PM sources and background loss rates. For example, the median $PM_{2.5}$ effectiveness for three portable air cleaners varied between 0% to 94% in residential, classroom, and office spaces. The effectiveness for a central system in a residence with electric and conventional media filters ranged from 0% to 50%. Within this variation, the portable air cleaner with a higher clean air delivery rate (CADR) and central air cleaner with a high-efficiency filter consistently demonstrated higher effectiveness across all environments although the degree of improvement was not proportional to the increase of CADR or filter efficiency. While larger spaces generally showed less effectiveness, this was not always the case as the effectiveness was influenced by the ventilation and sinks and sources of pollutants in the specific indoor environment. These findings emphasize the importance of understanding how air cleaners perform in various real-world conditions for selection and deployment.

10IP.4

2-Year Durability Comparison of HEPA vs MERV 16 vs MERV 13 Air Filters in DIY Air Cleaners Used Daily in Elementary and Middle Schools. 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 Winter of 2023 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 an initial batch of 5” MERV 16 filters used in the classrooms averages 77% after six months, 74% after 1 year, 63% after two years. This compared to 90% for HEPA after 2.5 years, and 86% for a more recent batch of MERV 16 after 1.5 years of use. 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. In a nearby middle school (grades 6-8), over twenty 5" MERV 16 and twenty 5" MERV 13 (half price of MERV 16) were installed DIY air cleaners during summer of 2023 and used daily in the classrooms. Filtration efficiency at 0.3 µm (most penetrating particle size) for these DIY air cleaners with MERV 16 and MERV 13 filters were initially 96% and 91%, and dropped to 90% and 78% respectively after approximately 6 months of daily usage. 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.

10IP.5

Measurements and Modeling of Indoor Air Pollutants and Mitigation Scenarios in Older Educational Buildings.

JIANING BAO, Nigel Kaye, Ehsan Mousavi, Christopher Post, Andrew Metcalf, *Clemson University*

Airborne transmission of pathogens highlights the need for safer building environments regarding indoor air quality (IAQ), especially for high-occupancy spaces, including classrooms at schools and colleges. As compared to newer buildings with modern central ventilation systems, older buildings generally have 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. Thus, it is important to evaluate the efficacy of ventilation systems in maintaining optimal IAQ and to explore mitigation strategies aimed at reducing pollutant levels in older educational buildings.

In this study, we use a Scanning Electrical Mobility Spectrometer (SEMS) and low-cost sensors to evaluate IAQ by measuring the concentrations of size-resolved particulate matter (PM) and carbon dioxide (CO_2) in classrooms from two different college buildings with outdated ventilation systems. Measurements are taken during controlled CO_2 and particle releases when the space is unoccupied, and during general occupancy to capture activity-induced emissions. By analyzing the exponential decay of PM and CO_2 concentrations over time, we evaluate and compare the effectiveness of the ventilation and filtration systems in different classrooms with varied conditions, such as room sizes, ventilation setups, and the addition of filtered box fans. 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 that can simulate CO_2 and size-resolved PM concentration under varied conditions. The box model reveals the infiltration rate to the space, which controls the trends in CO_2 and determines the level at which outdoor PM can affect IAQ. By simulating real-world scenarios, this study demonstrates that using a simple box model is a viable approach to finding feasible mitigation strategies to simultaneously address both PM and CO_2 pollution in an indoor space.

10IP.6

Characterization of Particulate Matter in Multi-Zonal Residential Apartment: Transport, Exposure, and Mitigation.

ALOK KUMAR THAKUR, Sameer Patel, *Indian Institute of Technology Gandhinagar*

Due to rapid urbanization and lifestyle changes, people in developing countries like India spend most of their time indoors, just like those in developed countries. However, indoor air pollution (IAP) studies in urban built environments in India are yet to gain impetus as most studies focus on ambient pollution. A few studies conducted so far are restricted to reporting pollutant concentration, providing limited insights into the source, transport, and fate of pollutants. Comprehensive studies are critical to assessing IAP severity and developing and deploying effective mitigation strategies in built environments.

We performed spatio-temporal monitoring of particulate matter (PM) in a multi-zonal residential apartment using a network of low-cost air quality monitors and research-grade instruments to characterize emission sources, assess transport metrics, estimate spatial exposure, and calculate I/O ratios. Exposure reduction efficacy of different mitigation measures was also tested. Sub-micron particles dominated number size distribution for cooking and incense. Operation of air conditioners (AC) led to faster transport of pollutants from the kitchen to the bedrooms. PM exposure in all zones relative to the kitchen ranged between ~0.8-0.9, indicating that occupants in and away from the emissions zone (kitchen) have comparable exposure. The average I/O ratios during cooking were elevated throughout the apartment, with the kitchen (10.1±8.9) and bedrooms (7.2±5.7 & 7.4±5.9) being the highest and lowest, respectively. Natural ventilation through balcony doors led to an average exposure reduction of 74-86% in different zones. AC operation reduced cumulative relative exposure, which was further reduced upon affixing a filter sheet on the AC pre-filter. Among the mitigation measures assessed, the highest cumulative loss rate (2.3±0.1 hr-1) was observed for the portable air cleaner with the default HEPA filter. The effect of increased filtration efficiency due to the added filter sheet was negated by the reduced flow rate.

10RM.1

Biologically Mediated Aerosol Precursor Emissions and Secondary Aerosol Formation along the Antarctic Ice Edge. EMILY FRANKLIN, Caleb Mynard, Joel Alroe, Marc Mallet, Ruhi Humphries, Robert Strzepek, Erin Dunne, *CSIRO Environment*

Volatile organic compounds (VOCs) produced by the interactions of phytoplankton, bacteria, and other members of the marine microbiome play a critical role in the formation of secondary marine aerosol over the ocean. This secondary aerosol material is known to play a critical role in cloud formation in the pristine marine atmosphere. The complex feedback loops between rapidly changing ocean conditions, marine microbiology, associated VOC emissions, and cloud formation over the ocean are incompletely understood and significantly contribute to climate model uncertainties. As part of the Multidisciplinary Investigations of the Southern Ocean (MISO) voyage, the Australian Research Vessel Investigator spent 19 days traversing the biologically productive Antarctic ice edge between 150 and 113 º E between 13 January and 1 February 2024. During the voyage, a suite of research-grade instrumentation was deployed to characterize VOC concentrations, aerosol size distributions, and aerosol composition. Preliminary results point towards particle formation and growth events characterized by rapid depletion of elevated atmospheric dimethyl sulfide (DMS) concentrations and increases in sulfate aerosol and semivolatile organosulfur concentrations. In addition to the ambient measurements, two sets of multi-day mesocosm experiments were conducted, in which natural ice-edge water with its complete microbial community was transferred into two 1,000 L tanks designed with isolated, low-oxidant headspaces. In each experiment, one tank was fertilized with iron while the other was maintained as a control. Preliminary results of the mesocosm studies indicate biologically-mediated changes in the relative distribution of marine organosulfur emissions between DMS and other species, particularly methanethiol (MeSH), as well as light-dependent emissions of isoprene. Together, these observations and experiments advance our mechanistic understanding of the complex feedback loops connecting ocean, aerosol, cloud, and climate.

10RM.2

Biogenic Volatile Nucleation Precursor Compound Fluxes from Pennsylvania Freshwater Lakes during 2023 Algal Bloom Season. CHRISTINE TROLLER, Coty Jen, Jeffery Butt, Rick Spear, Jamie Detweiler, *Carnegie Mellon University*

Freshwater algal blooms are becoming increasingly prevalent and are expected to produce emissions that significantly impact regional air quality and Earth's global climate processes as time proceeds. Microalgae and cyanobacteria emit various volatile organic compounds. These released compounds participate in atmospheric new particle formation, a complex process whereby cloud condensation nuclei are formed and impact cloud properties. Few freshwater lake emission measurements have been reported, thus limiting our understanding of their contribution to air quality degradation and cloud formation dynamics. In this study, nine 7-liter freshwater Pennsylvania lake samples were collected throughout June to September in 2023, peak algal bloom season. Gas fluxes of various compounds (i.e., ammonia, alkylamines, and other organic compounds) were measured from the water samples using a real-time water-to-air flux measurement system connected to a chemical ionization mass spectrometer. We report similar flux trends across the lake water samples regardless of cyanobacterial presence. However, water samples with significant concentrations of cyanobacteria tended to have a constant emission flux over 24 hours of measurements, while samples with little to no cyanobacteria decreased in emission flux. This is potentially due to the biological activity replenishing compounds in the lake water samples. Discovering relationships between lake emission fluxes and cyanobacterial presence will help us better understand how algal blooms may impact environmental dynamics. Additionally, reporting gaseous fluxes for nucleation precursors from freshwater bodies will lead to better modeling of future air quality and atmospheric processes.

10RM.3

The Impact of Planted Forests and Windbreaks on Reducing Dust Concentrations in Suburban and Urban Areas. BORIS KRASOVITOV, Andrew Fominykh, Avi Levy, Itzhak Katra, *Ben-Gurion University of the Negev, Israel*

Numerous studies reveal that human exposure to fine dust particles in the atmospheric surface layer during dust storms can increase the risk of worsening various bronchopulmonary and allergic diseases. Planting forests and tree belts (windbreaks) reduce airborne dust during dust storms, resulting in a better air quality in urban and suburban areas. This study investigates the effects of planted forests and windbreaks consisting of coniferous trees on the spatial distribution of PM_{10} concentrations in a region that is frequently prone to dust storms. The present study suggests the numerical model of Particle Deposition on a Forest Canopy (PDFC) supplemented by parameterization of the average collection rate based on the CFD model. 3D numerical modeling of the particulate flow utilizing discrete phase models based on the Eulerian-Lagrangian technique has been carried out. The vegetation element is considered as a prolate ellipsoid approximating in shape to a leaf of Aleppo pine (*Pinus halepensis*), the dominant tree species in the studied semi-arid zone (Northern Negev, Israel). Model predictions are validated against PM concentration measurements taken during dust storms in a pine forest using real-time dust monitoring devices. Numerical simulations performed using the developed model showed that in high-level dust storms, PM_{10} concentrations in a suburban environment located 2 km from the leeward side of the pine forest are reduced by 10.5%. Also, numerical analysis was conducted for highly porous windbreaks with widths of 1.25H and 2.5H, where H is the average height of the windbreaks. The calculations showed that windbreaks can decrease PM_{10} concentrations by 6-8%, even at a considerable distance (about 1 km) from the windbreaks. Modeling indicates that a combination of planted forests and windbreaks near urban areas, as well as vegetation within the city, can help clean and improve the quality of air entering urban areas.

10RM.4

Chemical Imaging of Biomass Burning Particles Present in the Summer Stratosphere. STEVEN SHARPE, Felipe Rivera-Adorno, Temitope Olayemi, Yaowei Li, Xiaoli Shen, Ryan Moffet, John Dykema, Frank Keutsch, Daniel Cziczo, Alexander Laskin, *Purdue University*

The increasing size, severity, and frequency of wildfires has led to drastic increases in particulate matter concentrations in the troposphere. However, pyrocumulonimbuses (pyroCB) generated by large scale wildfire events perturb the environment and inject biomass burning organic aerosols (BBOA) into the lower stratosphere. We have applied chemical imaging techniques as part of the Dynamic Chemistry of the Summer Stratosphere (DCOTSS) campaign in order to determine the composition, morphology, and mixing state of stratospheric BBOA; evaluate the effects of BBOA on stratospheric chemistry; and assess the optical properties of stratospheric BBOA. Chemical imaging with Scanning Transmission X-Ray Microscopy coupled with Near Edge X-Ray Absorption Fine Structure (STXM/NEXAFS) has allowed us to calculate the organic mass fraction and mixing state of stratospheric BBOA and provided high and low limit estimates of total alkene reactions with ozone. Our results are correlated with online PALMS and DPOPs instruments deployed during research flights in the stratosphere.

10RM.5

Aerosol Enhancement in the Tropical Tropopause Layer. SHANG LIU, Troy Thornberry, Pengfei Yu, Sarah Woods, Karen Rosenlof, Ru-Shan Gao, *Northeastern University*

As the main pathway for the transport of tropospheric air into the stratosphere, the tropical tropopause layer (TTL) largely determines the entry values for the materials entering the stratosphere. The properties of the TTL air and the processes occurring in the TTL thus affect the global stratosphere and climate. Aerosol particles play a critical role in the TTL through cloud formation and heterogeneous chemistry, influencing the radiative and chemical balance of the stratosphere. However, aerosol measurements in the TTL are sparse, resulting in poor knowledge of aerosol abundance and distribution in this important region. To gain a deeper insight into the abundance, spatial distribution, and formation mechanisms of TTL aerosols, we carried out aircraft measurements of aerosols over the western Pacific warm pool during the Pacific Oxidants, Sulfur, Ice, Dehydration, and cONvection (POSIDON) campaign in October 2016 using the NASA WB-57F high-altitude aircraft stationed in Guam. To complement the measurements, we employed the CESM-CARMA model to obtain insights into the chemical composition of the aerosols. The combined approach of aerosol measurements, tracer analysis, and modeling offers insight into aerosol abundance and formation mechanisms within the TTL. Our measurements reveal a persistent and altitude-dependent enhancement of aerosol mass in the TTL compared to the convectively influenced troposphere below. Notably, our data demonstrate a striking positive correlation between aerosol mass and ozone. Model simulations suggest that organic materials constitute a substantial fraction of the total aerosol mass within the TTL. We further derived an empirical parameterization of TTL aerosol mass as a function of ozone based on their linear relationship. This framework holds potential for estimating the TTL aerosol abundance but requires further validation and refinement through future measurements. The work has been published in Geophysical Research Letters in 2024.

10RM.6

Understanding the Impacts of Saharan Dust on Puerto Rico's Air Quality Using Air Sensors. DANIEL WESTERVELT, Andrea Belvis-Aquino, Hector Jimenez, *Columbia University*

The Saharan air layer (SAL) carries dry, dusty air from the Sahara Desert, which can travel thousands of miles across the Atlantic Ocean and impact air quality in the Caribbean and as far as the eastern mainland USA. Puerto Rico is particularly impacted by SAL during the months of June through September. Despite Puerto Rico's vulnerability, the existing air quality monitoring network faces limitations, especially in the distribution of PM10 monitors, which would capture a large influence of supermicron dust aerosol. Lower-cost optical particle counters (OPCs), which are skilled at measuring supermicron particles, can help fill this gap in observations of severe dust events and provide much needed data to air quality managers and other stakeholders. Here we analyze the impacts of the SAL on air quality as it moves across Puerto Rico. To address the observational gaps, we deployed five MODULAIR-PM monitors across the island to track the movement of SAL and its effects on air quality. The MOD-PMs include both a Plantower sensor an Alphasense OPC, the latter of which provides for more accurate estimation of both the aerosol size distribution and PM10 which is not possible with the Plantower alone. We first compared sensor data with reference PM2.5 and PM10 monitors provided by United States Environmental Protection Agency (EPA) to to evaluate the performance and potentially apply any post-hoc correction factors. Our initial findings reveal that hourly and daily PM10 observations from MOD-PMs have higher values when compared to EPA data for certain locations on the island, including Ponce, Puerto Rico. After evaluating and correcting the data, we define "supermicron PM" (PM10 - PM1) to identify SAL events. For summer 2023, about 6 distinct SAL events that impacted ground-level air quality were identified. These events were corroborated by satellite aerosol optical depth observations and true-color imagery provided by NASA. We also leverage the OPC size distributions to understand the typical size distribution of aerosols during SAL events, and contrast them with size distributions during non-SAL events. Ongoing research aims to refine these corrections and explore the influence of topography and meteorology on SAL in Puerto Rico. Overall, integrating air sensors in assessing the impacts of the SAL on Puerto Rico’s air quality can empower communities to make informed decisions and anticipate conditions effectively.

10SA.1

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, Rebecca Garland, Ann M. Dillner, *University of California, Davis*

The World Health Organization (WHO) estimates that about 91% of the global population live in regions with polluted air – resulting in approximately 7 million premature deaths annually. These deaths occur primarily in Low- and Middle-Income Countries (LMICs). Organic Matter (OM) often dominates PM2.5 mass warranting its quantification particularly in LMICs having limited PM measurements. In this study, we demonstrate the capability of Fourier-transform Infrared Spectroscopy (FT-IR) method for providing OM quantification and characterization in the Pretoria, South Africa (LMIC) at a Surface Particulate Matter Network (SPARTAN) site. The samples affected with Christiansen peak effect (scattering effect) were identified and a revised algorithm was employed to address this phenomenon. 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, every third day, from April 2021 to Dec 2022 (120 samples). The mean concentration of PM2.5 was 18.43 ug/m3. We present the daily, seasonal, and overall variation of organic and inorganic composition of collected PM2.5. Source classes and their geographical origins were determined through Positive Matrix Factorization (PMF) model, using the baseline corrected FT-IR Spectra, pollution roses, back trajectory analysis, correlation plots with inorganic species, and MODIS fire data products. Two sources were found: biomass burning & biogenic SOA (BB&SOA) and fossil fuel combustion (FFC) factors. BB&SOA was the dominant source in the winter and early spring while the FFC factor was ubiquitous with the dominant contribution in summer. The BB&SOA factor was further investigated for the individual factors with distinct origins: biogenic SOA, biomass burning, and industrial emissions mix source.

10SA.2

Measurements of Airborne Fine Dust and Ultrafine Particles at a Seaport in Southern Italy.

VOLKER ZIEGLER, Henrik Hof, Alessandra Genga, Tiziana Siciliano, Michele Gianelli, *Palas GmbH, Karlsruhe, Germany*

Airborne particles adversely affect human health, depending on their size. With decreasing size of particles deeper penetration of the respiratory tract is observed, and ultrafine particles smaller than 100 nm can pass into the blood vessel. Also, the specific surface area of particles, available for adsorption of potentially harmful substances, increases inversely proportional with diameter. While mass related limits for the PM10 and PM2.5 fine dust fractions are in place, and dust levels are monitored, the potentially more harmful PM1 fraction and the number concentration of nanoparticles are not under regulation today. Optical aerosol spectrometers can provide such data, as well as the number concentration and the size distribution of the aerosol particles, potentially allowing source apportionment in combination with data for other pollutants. We present results of a study carried out at a major seaport in southern Italy, which is expected to be affected by airborne particles emitted by naval engines of commercial and touristic shipping.

Among other instrumentation, a compact single particle counting aerosol spectrometer (AQ Guard Smart 1100, Palas GmbH) was used for analyzing the fine dust fractions between 0.18 and 18 µm size, while a charge diffusion based UFP analyzer (AQ Guard Smart 2000, Palas GmbH) was used to determine the particle number concentration of nanoparticles in the range 10 to 800 nm.

Various sources of emissions could be identified and their influence on the overall level of pollution by airborne particles could be evaluated.

10SA.3

Quantifying Biomass Burning Contributions to Winter Air Pollution in Interior Alaska. SARAVANAN KANAGARATNAM, Raghu Betha, Venky Shankar, *Texas Tech University*

Air pollution from carbonaceous aerosols (CA) is a serious concern in subarctic regions of Interior Alaska due to its far-reaching implications for the environment, climate, and public health. The city of North Pole within the Fairbanks North Star Borough (FNSB) in Interior Alaska experiences severe winter air pollution with average daily PM2.5 concentrations reaching up to 73 µg/m3. This led the EPA to designate the FNSB as a "serious non-attainment" zone in 2017 due to air quality concerns. Wood and other biomass burning is a primary source of residential heating in the region and is the main source of CA. However, there are no estimates of the source contributions to CA during winter. This research analyzed data from two one-month field campaigns using an aethalometer and total carbon analyzer to estimate the contributions of different sources to Black Carbon (BC) and organic carbon (OC). Existing methods for source apportionment require extensive data (often year-long data) and knowledge of specific source markers. This study proposed a new approach that doesn't need such extensive data or information on source markers, allowing for source estimates with smaller datasets. The results from the model show that the site-specific Absorption Ångstörm Exponent (α) values for biomass burning (α_bb), and fossil fuels (α_ff) were 1.87 and 0.93, respectively. It was estimated that biomass burning contributed 52 % to the BC (BC_bb) and 86%, to OC (OC_bb), while the fossil fuel contributed 48% to BC (BC_ff) and 14% to OC (OC_ff). These findings highlight the significant role of residential wood burning in winter air pollution in the North Pole. Biomass burning contributed over 80% of the OC and over half of the BC in the air. This information can be crucial for developing effective regulations to address air quality issues in the region.

10SA.4

Deconvolution of Post-Detonation Mixtures of Soot. MADELINE STRICKLIN, Ryan Farley, James E. Lee, Rachel Huber, Allison Aiken, *Los Alamos National Laboratory*

Most atmospheric soot is formed through incomplete combustion (e.g., from vehicle emissions, in-home heating/cooking, power plants, wildfires), and consists of submicron particles. While combustion soot is relatively well-studied, we present on the properties of detonation soot, which is produced by shock-driven decomposition at much higher temperature and pressure regimes. Bulk detonation soot exhibits a range of chemical properties depending on the fuel, detonation conditions, and environment, which can be useful for defining source-dependent signatures.

We use Soot Particle – Aerosol Mass Spectrometry (SP-AMS) to study these chemical signatures to distinguish different types of soot produced from different high explosive (HE) composites and different experimental conditions. The mass spectra identify chemical signatures that might be associated with different HE composites that are composed of "organic" materials (CHON) similar to natural fuels that produce combustion soot.

While distinguishing between pure samples of detonation soot is useful and we have done using a kernel-based algorithm, it is particularly advantageous to identify when a single sample of soot originates from multiple HE composites. Here, we consider mixtures of post-detonation soot according to the relative proportions of individual ions that exist within different moiety families (e.g., organics, nitrogen-containing organics, black carbon). This framework allows us to describe a sample of soot as a mixture of multinomial distributions over a fixed number of family types, where each multinomial distribution corresponds to a particular source of soot. We then use Latent Dirichlet Allocation to "deconvolve" this sample into its different parts. This allows us to infer not only the contributions of different types of HE to a mixture of soot, but also the profiles associated with these different types of HE. A comparison between this method and other more traditional AMS deconvolution techniques, such as positive matrix factorization (PMF), will also be presented.

10SA.5

PM1 Concentrations and Sources in Kigali, Rwanda. THEOBARD HABINEZA, Albert A. Presto, Allen Robinson, *Carnegie Mellon University*

Limited infrastructure and resources in Sub-Saharan African (SSA) countries have led to a scarcity of in situ air pollution measurements, hampering our understanding of pollution concentrations and sources. This challenge persists despite the pervasive influence of non-clean cooking fuels, outdated imported vehicles, rapid urbanization, and biomass burning on air quality, health, and the environment. In 2019, ambient air pollution was estimated to cause 4.2 million premature deaths globally, with 89% occurring in low and middle-income countries (LMICs). Thus, air pollution poses a significant public health burden, particularly in SSA and LMICs. To address this gap, we deployed an Aerosol Chemical Speciation Monitor (ACSM) and an Aethalometer in Kigali, Rwanda's capital, for continuous monitoring starting in March 2023. Rwanda, an East African country, is undergoing rapid urbanization and industrialization, with pollution influenced by both local and regional emissions. The ACSM measures particulate organic aerosol (OA), sulfate ($SO4^{+}$), ammonium ($NH4^{+}$), nitrate ($NO3^{+}$), and chloride (Cl^{+}), while the aethalometer measures light-absorbing particles at seven wavelengths. The measured annual PM_1 concentration in Kigali during the campaign was 34 µg m^{-3}, with OA contributing 71% of particulate matter mass, inorganic species contributing 10%, and black carbon accounting for 19% of the measured PM mass concentration. Marker ions in the average ACSM mass spectrum provide insights into important OA sources at this site, including traffic emissions, biomass/fossil fuel burning, cooking emissions, and photochemistry. Source apportionment of organic only PM 1 identified three source profiles dominated by Oxygenated Organic Aerosol (OOA, 50%), Hydrocarbon-like Organic Aerosol (HOA, 26%), and Biomass Burning-like Organic Aerosol (BBOA, 24%). A minor seasonal variation in PM mass concentration, chemical composition, and source profiles was observed during this campaign. The results of this study can inform policy measures to mitigate air pollution and its adverse health effects in SSA.

10SA.6

Resolving Particle Size Distribution into Biomass and Fossil Fuel Sources in Subarctic Alaska. LORENA ALBUQUERQUE ZANANDREIS, Saravanan Kanagaratnam, Raghu Betha, *Texas Tech University*

Atmospheric aerosol particles come in various sizes. Their size and composition significantly influence how they interact with light and other atmospheric components. Consequently, Particle size distribution (PSD) is crucial in simulating aerosol effects on climate, aerosol transport and deposition, and air quality and cloud formation modeling. In addition, PSD is also important in health risk modeling. Despite its importance, PSDs are not routinely monitored by regulating authorities. This information is not readily available and is notably lacking in the polluted subarctic regions of Alaska. In this study, submicron PSDs were measured using a Scanning Electrical Mobility Spectrometer (SEMS) in the city of North Pole in Interior Alaska during a month-long wintertime campaign. The region is heavily polluted in wintertime due to atmospheric inversion and the widespread use of biomass burning for residential heating. The study revealed a strong inverse non-linear relationship between the total number-to-volume (N/V) ratio and Absorption Ångstörm Exponent (AAE) of particles, indicating that higher AAE values correspond to larger particle sizes. Additionally, diurnal variations in particle sizes were observed, with larger mean diameters (Dg) of particles in the afternoon and night. The mean diameters of PSDs were found to be inversely proportional to temperature. The PSDs are further resolved into two primary sources in the area (fossil fuel (FF) and biomass burning (BB)) using a reduced gradient optimization approach. Preliminary results indicate that BB contributes to more than half (52 ± 25%) of the total particle counts, with a geometric mean diameter of 114 ± 2.1 nm. Fossil fuels account for 48 ± 10% of total particle number with a mean diameter of 61 ± 1.8 nm. By identifying the specific contributions of different sources and particle sizes, this research offers valuable insights into the complex dynamics of aerosol pollution in subarctic Alaska.

11AC.1

Ions from Solid Particle Surfaces: Probing Particle Surface Composition with Matrix-Assisted Ionization in Vacuum - Mass Spectrometry. LISA WINGEN, Yiming Qin, Elizabeth Wingen, Cheyenne Begay, Véronique Perraud, Styliani Consta, Michelia Dam, James Smith, Barbara Finlayson-Pitts, *University of California, Irvine*

Atmospheric particles impact health, visibility, and climate. Many of the processes that control these impacts begin at the air-particle interface, such as particle growth, water uptake, and heterogeneous chemistry. Analytical methods are needed to examine particle surface composition at a molecular level to improve our fundamental understanding of these processes. A surface-sensitive mass spectrometry technique is presented that provides molecular identification within solid particle surface layers in real time, but does not require the use of an external ionization source. Matrix Assisted Ionization in Vacuum - Mass Spectrometry (MAIV-MS) utilizes atomized and dried dicarboxylic acid particles from which surface ions are expelled as the particles evaporate in the inlet of a mass spectrometer. The surface sensitivity of MAIV-MS is demonstrated through particle coating experiments in which thin surface coatings of different compounds are detected, while signal from the core is relatively low in comparison. Peak intensity is shown to scale with the surface area of particles rather than their number or volume. Application of MAIV-MS to heterogeneous hydroxyl radical oxidation of solid glutaric and adipic acid particles led to the detection of organic peroxides at unexpectedly high signal intensities relative to the stable alcohol and ketone products. The online MAIV-MS particle method involves soft ionization, permitting more sensitive detection of peroxides that readily decompose using common offline analysis techniques. Insight into the ion generation mechanism from solid particles based on theoretical studies and additional applications of MAIV-MS will be discussed.

11AC.2

Interfacial Enrichment of Lauric Acid Assisted by Long-Chain Fatty Acids at Sea Spray Aerosol Surfaces Intrigues Climate-Relevant Properties. MICKEY ROGERS, Abigail Dommer, Kimberly Carter-Fenk, Nicholas Wauer, Patiemma Rubio, Aakash Davasam, Heather Allen, Rommie Amaro, *Pacific Northwest National Laboratory*

Surfactant monolayers at sea spray aerosol (SSA) surfaces regulate various atmospheric processes including gas transfer, cloud interactions, and radiative properties. Most experimental studies of SSA employ a simplified surfactant mixture of long-chain fatty acids (LCFAs) as a proxy for the sea surface microlayer (SSML) or SSA surface. However, medium-chain fatty acids (MCFAs) make up nearly 30% of the FA fraction in nascent SSA. Given that LCFA monolayers are easily disrupted upon the introduction of chemical heterogeneity (such as mixed chain lengths), simple FA proxies are unlikely to represent realistic SSA interfaces. Integrating experimental and computational techniques, we characterize the impact that partially-soluble MCFAs have on the properties of atmospherically-relevant LCFA mixtures. We explore the extent to which the MCFA lauric acid (LA) is surface stabilized by varying acidity, salinity, and monolayer composition. We also discuss the impacts of pH on LCFA-assisted LA retention, where the presence of LCFAs may shift the surface-adsorption equilibria of laurate—the conjugate base—towards higher surface activities. Molecular dynamic simulations suggest a mechanism for the enhanced surface retention of laurate. We conclude that increased FA heterogeneity at SSA surfaces promotes surface activity of soluble FA species, altering monolayer phase behavior and impacting climate-relevant atmospheric processes.

11AC.3

Surface Crust Formation in SOA Leads to Reduced and Nearly Size-independent Evaporation.

MEREDITH SCHERVISH, Jacqueline Wilson, ManishKumar Shrivastava, Alla Zelenyuk, Manabu Shiraiwa, *University of California, Irvine*

The measurements of room-temperature evaporation kinetics of size-selected α-pinene SOA has shown to exhibit nearly size-independent evaporation behavior characterized by a rapid initial evaporation stage in a few hours, followed by a slow evaporation stage. Similar evaporation behavior was observed for aerosols particles containing high molecular weight polyethylene glycol (PEG) mixtures and other polymer-containing mixtures. It is hypothesized that this size-independent evaporation can be explained by the accumulation of low-volatility, high molecular weight, highly viscous species at the surface of the particle during evaporation. In the α-pinene system, where particle-phase oligomers are present, decomposition of these oligomers has also been shown to contribute to nearly size-independent evaporation. We applied the kinetic multilayer model of gas-particle interactions (KM-GAP) to simulate the evaporation in the PEG and α-pinene systems. A composition-dependent diffusivity is implemented in each particle bulk layer. Additionally, in the α-pinene SOA system oligomer decomposition is implemented. KM-GAP is also used to simulate condensation onto these evaporated particles to explore the effect of surface crust formation on growth. We show that surface crust formation occurs during evaporation when the diffusivity of the initially homogeneous bulk reaches below 10-14 $cm^2 s^{-1}$. As evaporation continues, the diffusivity of the outer bulk layers will continue to decrease at a faster rate than the internal layers, forming the surface crust. The formation of this crust significantly reduces the size dependence of evaporation in both systems by limiting further evaporation. In the α-pinene system, oligomer decomposition additionally reduces the size-dependence of evaporation and reproduces the two-stage evaporation from experiments.

11AC.4

Measuring the Surface Tension and Composition of Model "Electrospray" Microdroplets.

MICHAEL JACOBS, *Texas State University*

Numerous classes of reactions (from condensation to redox to biomolecular) have been reported to occur several orders of magnitude faster (up to 10^{11}!) in microdroplets than equivalent reactions in beaker-scale solutions. While many studies attribute these large rate enhancements to the increased importance of and accelerated interfacial chemistry, most techniques study droplets from electrospray sources and are unable to decouple surface-driven chemistry from other acceleration mechanisms (e.g., solvent evaporation or potential gas phase chemistry). This leaves many lingering questions, including: How do interfacial reactions accelerate chemistry in microdroplets when the kinetic timescale for molecules to sample the air-water interface (>10s ms) is much longer than the lifetime of electrospray droplets (<1 ms)? As a result, complementary techniques with more control over microdroplet size and composition are needed to develop a fundamental understanding of which physicochemical properties are responsible for the accelerated chemistry in microdroplets.

We use a quadrupole electrodynamic trap to measure the physicochemical properties of and chemical reactions in levitated microdroplets with well characterized composition and size. In this talk, we will present our recent work to explore how the large surface charge densities found in electrospray microdroplets affects molecular transport to and concentration at the air-water interface. We use quasi-elastic light scattering to measure the surface tension of microdroplets of varying size, charge, and composition. Kinetic modeling is used to relate measured surface tension to interfacial concentrations. Preliminary results indicate surface tension decreases as microdroplets charge approaches the Rayleigh limit. These results could be indicative of charge-facilitated mass transport to the air-water interface and suggest reactions rates at electrified air-water interfaces are distinct from their uncharged counterparts. Ultimately, we are working to develop a fundamental understanding of molecular transport to the electrified air-water interface that can (partially) explain the unique chemistry of microdroplets.

11AC.5

The Uptake and Spontaneous Oxidation of HONO to Optically Tweezed Aerosol Droplets is Self-Accelerated by Aerosol Acidity.

Luke Monroe, GRAHAM THORNHILL, Jack Hall, Ryan Sullivan, *Carnegie Mellon University*

Nitrous acid (HONO) is as an important reservoir species for reactive nitrogen oxides that are ozone precursors in the atmosphere, and a potential source of nitrite in aerosol particles. While HONO is known to undergo numerous important surface chemistry reactions, its uptake and reactivity in tropospheric aerosol has largely been ruled out. This is due to the high acidity of atmospheric aerosol that is assumed to inhibit aerosol uptake by keeping NO_2^- in its protonated and volatile HONO form. The aerosol optical tweezers with its cavity-enhanced Raman spectroscopy and whispering gallery modes allows us to distinguish between NO_2^- and NO_3^- in single-levitated droplets in real-time using measurements that do not perturb the droplet's properties or reaction kinetics. Evidence for the rapid oxidation of HONO to HNO_3 was observed and is attributed to a reaction occurring at the air–water interface involving a HONO dimer. NO_2^- was never observed while the rapid production of NO_3^- was found to be a strong function of the pH and buffering capacity of the droplet. HONO oxidation to HNO_3 was accelerated in unbuffered droplets compared to buffered droplets that resist acidification. In droplets also containing organonitrate SOA from nitrate oxidation of terpenes, reactive uptake drives morphology changes due to acidification by N_2O_5 hydrolysis or HONO oxidation to HNO_3. The evolution from an aqueous homogeneous to a biphasic core–shell morphology shifted the chemistry from nitrite oxidation to nitrate to the $N_2O_5/NO_3\bullet$ oxidation of the new organic shell phase. Numerous Raman modes from the organic products were observed which provide evidence for a long lifetime of these components versus hydrolysis. These results offer new insights into the nighttime sink processes of HONO and nitrite in coarse mode aqueous aerosol particles. HONO uptake to supermicron aerosol may be an unrecognized sink of NOy that also facilitates multiphase chemistry of HONO.

11AE.1

Inequity of Exposure to Wildfire Smoke PM2.5 in the United States.

JING LI, Xinlei Liu, Qiao Yu, Yifang Zhu, *University of California, Los Angeles*

Understanding the inequity of exposure to wildfire smoke PM2.5 is limited, particularly lacking consideration of indoor infiltration. Here, we aimed to address this gap by quantifying smoke PM2.5 exposure in 2020, considering both indoor infiltration and time spent outdoors and indoors at the census tract level, and examining disparities using various vulnerability variables. Additionally, we incorporated data on the prevalence of residential air conditioning (AC) to investigate its impact on the inequity of smoke PM2.5 exposure across the U.S. Our results revealed that vulnerable populations were disproportionately exposed to higher levels of smoke PM2.5, with 25% of the most vulnerable population being exposed to 31% of smoke PM2.5. In addition, we found that smoke PM2.5 exposure varied more by race-ethnicity than by income. Annual population-weighted racial-ethnic exposure disparities across the U.S. and California exhibited differences. Nationally, Natives, Asians, Hispanics, and others (some other race or two or more races) were more exposed than average. In California, however, Asians and Hispanics flipped to be less exposed than average, while Whites were more exposed than average. These shifts can largely be attributed to the fact that within the United States, compared with other states, Asians and Hispanics are primarily concentrated in California, a state with the highest risk of wildfires in the U.S. Furthermore, we found that the prevalence of residential AC systems exacerbated smoke PM2.5 exposure inequity at the national level but mitigated it in California. This underscores the importance of investigating disparities in exposure to smoke PM2.5 from the bottom up to better address this inequity based on local conditions. In summary, our findings emphasize the imperative need to incorporate smoke PM2.5 into air quality assessments and control practices to enhance protection for vulnerable populations, as well as the importance of addressing this environmental inequity at the local scale.

11AE.2

Microenvironmental Apportionment Explains Demographic Differences in PM2.5 Exposure within a Rural Rwandan Biomass Burning Community. KY TANNER, Maggie L Clark, Vincent Cleveland, Egide Kalisa, Christian L'Orange, Richard Mori, Theoneste Ntakirutimana, Casey Quinn, Christian Sewor, Kellin Slater, Jessica Tryner, Rebecca Witinok-Huber, Bonnie Young, John Volckens, *Colorado State University*

In 2019, household air pollution from solid fuels was ranked as the 9th leading risk factor for premature mortality with 2.3 million estimated annual deaths worldwide. This estimate, however, was based on assumptions about exposure that have not been fully validated. We assessed demographic variation on personal exposures in rural communities, and behavioral factors related to this variation. This work analyzed data collected from female and male heads-of-household and children aged 8-17 years during the baseline phase of a household energy intervention study in Eastern Rwanda, where biomass is the primary means of cooking fuel. We collected one 48-hour sample of personal real-time (optical sensor, SPS30) $PM_{2.5}$ concentration data, and a corresponding time-integrated (filter-based) exposure sample, for correcting the real-time data, from each of 1,258 participants in 574 households over a ~15-month period using a UPAS sampler. We developed linear mixed models, accounting for household random effects, that suggested women were exposed to 178% (CI: 163, 194%) higher PM2.5 levels compared to their men, who had a median exposure of 96.2 $\mu g/m^3$, and children's were 189% (CI: 174, 206%) higher than the men. Personal $PM_{2.5}$ exposures did not vary with socio-economic status, with the wealthiest participants having similar exposures to the poorest based on an asset-weighted index. Microenvironmental classification was applied to 30-second GPS data using a novel approach combining machine learning (density-based spatial clustering) with geocoded zonal boundaries. The microenvironmental classifications matched with real-time $PM_{2.5}$ observations indicated the highest exposures across demographics occurred at home during the evenings in the dry season, while the lowest happened mid-day while in transit outside the village during the wet season. Analysis suggested men spent about 20% less time in the home (the highest exposure microenvironment) than women and children, and this discrepancy explained the within-household variation in exposure.

11AE.3

Personal Exposures to Fine Particulate Matter in Java, Indonesia Using Low-Cost Sensors. MARINA VANCE, Bregas Budianto, Gito Immanuel, Hideki Nara, Shigeru Hashimoto, Yukio Terao, Rizaldi Boer, *University of Colorado Boulder*

This work investigates PM2.5 concentrations in Bogor, Indonesia. The city of Bogor is located in the Jakarta metropolitan region, the most populous metropolitan area in Indonesia. Home to an estimated 35 million people, the Jakarta metro region is considered the 5th largest megacity in the world. This work investigates PM2.5 concentrations in Bogor, West Java using a fixed air monitoring site as well as personal exposures using low-cost sensors. Researchers equipped with a PM2.5 and a CO2 monitors carried out daily activities and kept a detailed time-activity log over the course of 8 months, spanning the dry and rainy seasons. Additionally, two types of low-cost PM2.5 monitors were collocated with a regulatory-grade, ambient air quality monitoring station throughout the campaign. Collocation results were used to apply correction factors to the personal exposure data and to gain insights on environmental factors affecting sensor performance (e.g., relative humidity and aerosol composition). Preliminary results show a 24-hr average PM2.5 concentration of 26 +- 13 µg/m3 with a slope of 0.56 µg/m3 compared to the fixed monitoring station. There were statistically significant differences ($p<0.01$) in personal exposure between transport modes (i.e., car, motorcycle, walk) and between indoor locations (e.g., mall, office, home). While the average PM2.5 concentrations experienced by motorcycle were over 2x higher than by car, the total exposure in the motorcycle scenario very similar to the car scenario. This is because the bulk of exposure took place at home and in the office.

11AE.4

Personal Exposures to PM2.5 by Microenvironment among Residents of California's Central Valley. JESSICA TRYNER, Xiaoying Li, Luis Hernandez Ramirez, Bonnie Young, Sherry WeMott, Mollie Phillips, Grant Erlandson, Celine Campos, Daniel Dean, Nayamin Martinez, John Volckens, Sheryl Magzamen, *Colorado State University*

People are exposed to particulate matter (PM) air pollution in varied environments, including at home, at work, and in transit. As a result, a person's exposure to PM often differs from the local outdoor concentration. We measured personal and in-home PM concentrations for 149 participants from 88 households across urban and rural communities in California's Central Valley. We used wearable monitors to collect 24-h time-integrated filter samples, time-resolved optical sensor data on PM concentration, and time-resolved GPS data to investigate spatiotemporal variations in personal exposure to $PM_{2.5}$. We clustered GPS coordinates using machine learning to identify key locations where participants spent time and were exposed to $PM_{2.5}$. Daily average personal exposures tended to exceed outdoor concentrations (median personal = 15.7 $\mu g\ m^{-3}$; median personal - outdoor difference = 5.8 $\mu g\ m^{-3}$). Personal exposures to $PM_{2.5}$ were better correlated with in-home concentrations than with outdoor concentrations (Spearman correlation = 0.63 versus 0.24). Most participants (59%; "Group 1") spent > 80% of their time indoors at home, where they received a proportional amount of $PM_{2.5}$ exposure. Some participants (28%; "Group 2") received a disproportionately large amount of $PM_{2.5}$ exposure in their homes despite spending less time there. A smaller proportion (13%; "Group 3") spent ≤ 80% of their time indoors at home and received a disproportionate amount of $PM_{2.5}$ exposure elsewhere. Among Group 3 participants, the non-home environments associated with the largest fractions of exposure were agriculture and transit. Participants in Group 3 were more likely to work outside the home (80% in Group 3 versus 37% in Group 1) and were more likely to work in agriculture (83% of employed participants in Group 3 versus 50% in Groups 1 and 2), thus highlighting the relevance of occupational exposure to PM in this study population.

11AE.5

Efficacy of a Novel Personal Nasal Sampler (PNS) in Capturing Particles and Viruses. TAEWON HAN, Gediminas Mainelis, *Rutgers, The State University of New Jersey*

We recently developed a novel personal sampling concept for determining personal exposures to airborne microorganisms: a personal nasal sampler (PNS). PNS was designed by applying an electrospun nanofiber filtration approach: a thin coat of electrospun polyvinylidene fluoride (PVDF or P(VDF-TrFE) polymer nanofibers was laid over a conventional non-woven microfibrous base to form a hybrid filter (HF). The sampler with HRF attaches to a user's nostrils and utilizes the person's breathing to capture airborne infectious agents, directly measuring actual personal exposure to those agents. First, we optimized the new HF and, after multiple iterations, settled on a version where PVDF nanofibers are electrospun over a pulmonary test filter (PTF). This optimized HF showed collection efficiency of over 90% for a wide range of particle sizes (10 nm-10 µm) when tested with sodium chloride aerosol. We further investigated the collection efficiency of single versus multiple-layered HFs with NaCl and bacteriophage Phi6, a popular surrogate for SARS-CoV-2. The RNA of the collected virus was extracted using TRIzol (Thermo Fisher Scientific Co.) per the manufacturer's protocol. Extracted RNA was quantified by determining the absorbance at 260 nm using a NanoDrop spectrophotometer.

The newly developed PNS with double-layered HFs showed a collection efficiency of 98% compared to the efficiency of 92% of a single-layer HF at 5 L/min per 13 mm filter; however, the quality factor (QF), which integrates the filtration efficiency and pressure drop, showed that a single-layer HF had 1.8× better overall performance. When testing with the Phi6 virus, we achieved collection efficiency of 98% at 5 L/min and 80% at 10 L/min. In ongoing tests, the PNS is installed on a mannequin and operated in different occupational environments. The presented sampler concept shows promise in determining personal exposures to viral particles.

11CC.1

Aerosol-Induced Intensification of Temperature Maxima during a Mega Heatwave Event in India. Arushi Sharma, CHANDRA VENKATARAMAN, Arpita Mondal, Manish Dhasmana, Dewashish Tiwari, *Indian Institute of Technology Bombay*

Despite global temperature effects of aerosols being governed by their light absorbing (warming, e.g. black carbon or BC) or scattering (cooling, e.g. sulfate) nature, increases in regional aerosol concentrations are widely believed to cool local, near-surface temperatures. Epidemiological studies suggest an exponential increase in heat-related mortality for the most extreme temperatures, making it crucial to estimate whether aerosol radiative feedback can intensify or weaken temperature maxima during heatwaves. The 2015 mega heatwave event in South Asia claimed 2000 lives in India and 1500 lives in Pakistan.

Here we evaluate aerosol influence on both dry and moist heat stress during the event, using simulations with the chemical transport model (WRF-Chem using RADM2-SORGAM chemistry and MADE microphysical schemes), deploying emissions from a regional emission inventory. Dry heat stress was quantified as the daily maximum dry bulb temperature (T_{max}), while moist heat stress as the daily maximum wet bulb temperature (WBT). The difference between a pair of WRF-Chem simulations with (i) both aerosol direct and indirect radiative effects switched on (BASE) and (ii) the aerosol radiation interaction switched off (NoARI), was exploited in the work.

The heatwave period was evaluated to reveal two distinct aerosol-induced effects, both of which led to an intensification or warming of extreme temperatures, thus exacerbating heat stress. During May 22nd-Jun 7th, 2015, aerosols induced an enhancement of dry heat stress (ΔT_{max}~0.5-2°K; averaged over 15°N-27.5°N; 71°E-85°E), driven by enhanced black carbon concentrations (ΔBC~0.5-1.5 µg m^{-3}). Following this, during Jun 8th-30th, 2015, an increase in moist heat stress (ΔWBT~0.5-2°K), was driven by enhancements in daily relative humidity (ΔRH~1-10%). The paper will discuss the underlying mechanism, which includes absorbing-aerosol induced atmospheric stabilization, leading both to changes in surface energy fluxes and a confinement of moisture in the surface layer, worsening heatwave intensity.

11CC.2

Assessing the Removal of Particles by Precipitation and Quantifying Their Wet Deposition Rates. CHRISTOS STAMATIS, Chenyang Bi, Gabriel Isaacman-VanWertz, *Virginia Tech*

Secondary organic aerosol (SOA) levels in the atmosphere are affected by the thermodynamic equilibrium between reactive organic gases and particles. Therefore any processes such as wet and dry deposition that removes particles, will affect the thermodynamic equilibrium and the formation of SOA. Unfortunately, there are few direct observational constraints on the wet deposition of 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 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. Direct observations of removal are combined with precipitation data to calculate scavenging coefficients that are size-dependent for particles. Using data from Lamont, Oklahoma (2017-2023) and Manacapuru, Brazil (2014 - 2015) we quantify removal rates as a function of particle size during rain events. Wet scavenging of particles is similar at both sites across the measured submicron size range, with an interesting and complex size dependence. We examine scavenging at diverse geographical locations and compare to theoretical scavenging equations to better understand wet deposition timescales for particles and how precipitation parameters such as precipitation duration, intensity and droplet size distribution affects aerosol wet deposition.

11CC.3

Investigating the Impact of Seawater Divalent Cations on the Surface Tension of Aerosol Containing Ionic Surfactants. ALISON BAIN, Kunal Gosh, Konstantin Tumashevich, Nønne L. Prisle, Bryan R. Bzdek, *University of Bristol*

Quantifying the surface tension of aerosol is of great interest in part due to field observations identifying larger concentrations of cloud condensation nuclei (CCN) than expected from model predictions. A common assumption to these model predictions is that the surface tension of aerosol droplets is equal to that of pure water. However, using this assumption, the surface tension of surfactant-containing aerosol may be overpredicted. Reducing the surface tension of aerosol lowers the barrier to cloud droplet activation and leads to higher predicted CCN concentrations.

Sea spray aerosol, one of the largest aerosol sources by mass, is known to be a complex mixture of inorganic salts and surface-active organics. A reduction in aerosol surface tension due to surfactant adsorption has been suggested to explain discrepancies between CCN observations and predictions. Surface tension is typically measured using macroscopic samples, but in high surface-area-to-volume ratio droplets, surfactant partitioning to the interface can leave the bulk concentration depleted, thus requiring a larger total surfactant concentration to reduce the surface tension. Recent work has focused on surfactant-water or surfactant-NaCl solutions but divalent cations, which are present in seawater, are known to significantly impact the partitioning of ionic surfactants.

We previously showed the bulk surfactant depletion experimentally for nonionic surfactants in aerosol droplets containing glutaric acid or NaCl cosolutes. Here, we extend surface tension measurements of single, picolitre volume droplets to ionic surfactants and compare the results to two partitioning models. Additionally, we investigate the impact of a sea salt mixture containing divalent cations on the partitioning of ionic surfactants in aerosol droplets. These results are compared to our previous knowledge of nonionic surfactant-containing aerosol droplets.

11CC.4

Optical Property and Hygroscopicity of Solid Strongly Absorptive Brown Carbon in Wildfire Smoke. ZEZHEN CHENG, Amna Ijaz, ManishKumar Shrivastava, Daniel Veghte, Gregory W. Vandergrift, Kuo-Pin Tseng, Nurun Nahar Lata, Will Kew, Kaitlyn J. Suski, Johannes Weis, Gourihar Kulkarni, Larry Berg, Jerome Fast, Libor Kovarik, Lynn Mazzoleni, Alla Zelenyuk, Swarup China, *Pacific Northwest National Laboratory*

Brown carbon (BrC) emitted from wildfires is a significant contributor to atmospheric aerosols. They affect climate directly by absorbing and scattering light and indirectly by interacting with clouds. However, the knowledge of the climate effects of wildfire BrC is still limited. One reason might be a limited understanding of strongly absorptive BrC (solid S-BrC, commonly known as tar ball) in wildfire aerosol. Literature reported solid S-BrC optical properties are highly variable, leading to significant uncertainties about their direct climate effects. Moreover, the interaction between solid S-BrC and clouds is typically neglected due to the common belief that they are hydrophobic. Here, we investigate the physicochemical and optical properties of solid S-BrC collected from the Pacific Northwest wildfire in September 2017, where more than 90% of particles are solid S-BrC with measured refractive index at 550 nm wavelength equal to 1.49+0.059i. Sensitivity studies of solid S-BrC absorption aerosol optical depth (AAOD) using the Weather Research and Forecasting Model coupled to chemistry (WRF-Chem) show that variation in RI can lead to ~ 200% difference in AAOD, which could lead to surface temperature difference. Furthermore, we found that ~50% of solid S-BrC particles are hydrophilic and can form core-shell morphology at 5 ºC and > 97% RH, possibly due to a highly oxygenated surface layer, making them potential cloud condensation nuclei. This core-shell morphology could enhance their absorption cross-section at 550 nm by a factor of 2 due to the lensing effect. In addition, SEM images show that at least 1% solid S-BrC has organic coatings, which leads to higher lensing enhancement than water coating. We conclude that more studies are necessary for models to improve the parametrization of the light-absorption properties of wildfire aerosol to incorporate the contribution of solid S-BrC and their interactions with water to predict Earth’s radiation budget accurately.

11CC.5

Black Carbon Mixing State Evolution in Shallow and Deep Convective Wildfire Plumes. MANVENDRA DUBEY, James E. Lee, Kyle Gorkowski, Ryan Farley, Katherine Benedict, Allison Aiken, Eunmo Koo, Jon Reisner, *Los Alamos National Laboratory*

Black carbon (BC) mixing state (internal, coated (core-shell or extruded), or external) determines the optical and hygroscopic properties of smoke emitted by wildfires and their effects on climate. Organic carbon (OC) and water coated BC can enhance light absorption. While fresh BC is hydrophobic, mixing with hydrophilic species can reduce its burden and promote cloud formation and evaporation. Field observations of BC coating thickness in shallow smoke plumes reveal growth in the near field by condensation and coagulation followed by a decline by evaporation.[1] Observations of aged wildfire smoke plumes transported over long range show coating effects that depend on environmental conditions.[2,3] Finally, recent observations of thickly coated BC particles injected into stratosphere injected by deep convective Pyrocumulous events identify a new regime that is not well understood.[4] We develop a reduced order modeling and analysis framework to understand evolution of BC mixing as a function of OC, photochemistry, temperature, humidity, and cloud processing to understand these different coating behaviors.[5] We discuss how cloud chamber studies can help elucidate these complex effects. Top-down field observations and bottom-up cloud chamber experiments should help develop validated or empirical BC mixing state parametrizations in climate models.

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[2] Lee, J. E. et al. *Geophys. Res. Lett.*, 49, e2022GL099334, 2022.
[3] Lee, J. E. et al. *JGR: Atm*, 125, e2020JD032399, 2020.
[4] Katich, J. M. et al. *Science*, 379, 815–820, 2023.
[5] Gorkowski, K. et al. *Environ. Sci.: Atmos.*, 4, 80-87, 2024.

11CO.1

Results and Spacecraft Fire Safety Implications from the Saffire IV-VI Microgravity Combustion Experiments. CLAIRE FORTENBERRY, David Urban, John Easton, Justin Niehaus, *NASA Glenn Research Center*

A spacecraft fire represents a life- and mission-threatening scenario for any space flight or exploration mission. Due to the unique combustion and transport physics under reduced gravity and the need for rapid trace contaminant removal to conform to habitation requirements, spacecraft fire detection approaches must combine appropriate selection of detector technologies with their strategic placement within the spacecraft cabin. The most recent spacecraft fire detectors (abord the Shuttle and ISS) have relied on smoke particle detectors developed for terrestrial applications, and previous microgravity smoke studies have demonstrated that the efficacy of these detectors depends on aerosol size, composition, and morphology. Additionally, because spacecraft particle filtration rates may outpace smoke generation in early-fire scenarios, and because of disruptive false alarms due to nuisance cabin aerosol, a gas-phase detection target could ultimately supplement smoke particle sensors for a more robust detection strategy. Thus, particle and gas composition and concentration data from real reduced-gravity fires with relevant spacecraft materials are needed to optimize fire detection and ensure crew safety for future low-Earth orbit, Lunar, Martian, and deep space missions.

The Saffire series of experiments were conducted by NASA on Northrop Grumman Cygnus vehicles following completion of their primary ISS resupply missions. As Cygnus maintained low-Earth orbit, spacecraft-relevant materials were ignited to investigate flame behavior under different pressure and oxygen conditions. Although Saffire I-III focused primarily on obtaining flame spread and heat release information, Saffire IV-VI incorporated particle and gas sensors in the far field of the vehicle to track smoke transport and evolution over time. Here, we present particle and gas composition, concentration, and evolution results for fire experiments conducted during Saffire IV-VI. We also discuss implications for spacecraft detection strategies, including times to alarm and potential fire survivability.

11CO.2

Soot Formation in a Laminar Non-Premixed Planar Mixing Layer Flame (PMLF) Fueled by Ethylene Doped with Iso-Dodecane. CHRISTIAN P. BJORK, Evangelos K. Stefanidis, Mahmoud K. Ashour, Scott W. Wagnon, Chiara Saggese, Francesco Carbone, *University of Connecticut*

Iso-dodecane isomers are pivotal components of any surrogate mixture of Sustainable Aviation Fuels (SAFs) whose usage would, therefore, be accelerated by developing a validated chemical kinetic model of their combustion. This development requires an experimental database unraveling the complex pyrolysis and oxidation chemistry of such long-chained and highly-branched alkanes. Hence, this study examines the doping of a slightly sooting laminar non-premixed, ethylene-fueled, Planar Mixing Layer Flame (PMLF) with 1500 ppm of 2,2,4,6,6-pentamethyl-heptane. The PMLF is unconfined and stabilized between adjacent slot jets of the fuel and oxidizer streams being sandwiched between annular shielding nitrogen. The flow is stabilized by exhausting the hot buoyant flame products through a slot in a plate onto which the remaining cold flow impinges. Importantly, any horizontal cross-section of the PMLF has the self-similar structure typical of a boundary layer that grows at increasing Height Above the Burner (HAB) and can be modeled as a 1D Counterflow Flame (CF) which is several millimeters thick and, hence, not accessible in CF experiments. Thanks to these characteristics, the PMLF is ideal for performing spatially resolved measurements with minimal effects of the sampling-induced perturbations, to develop and validate detailed chemical kinetic models. The horizontal profiles of C0-C18 gas species and soot are measured at HAB = 25 and 50 mm using capillary sampling followed by GC/MS analysis and Laser Induced Emission Spectroscopy (LIES), respectively. The comparative analysis of the results in the baseline PMLF fueled only by ethylene with those in the doped PMLF in which 1500ppm of ethylene with 2,2,4,6,6-pentamethyl-heptane demonstrates that the doping boosts the mole fraction of several aromatics and the soot volume fraction at both HABs by approximately 120% and 50%, respectively. The experimental results partially validate the tested state-of-the-art detailed kinetic model and also point toward the further improvement of its predictive capabilities.

11CO.3

Highly Porous Carbon Blacks for Supercapacitors and Electrochemical Energy Storage. GEORGIOS A. KELESIDIS, Nicola Rossi, Ayca G. Senol, Christian Prehal, Sotiris E. Pratsinis, *Rutgers, The State University of New Jersey*

Supercapacitors are essential for efficient energy storage in power electronics, as well as to complement Li-ion batteries for short-time energy delivery and harvesting in hybrid/electric vehicles and other transportation systems. These devices rely on porous carbonaceous materials, such as activated carbons, that have large specific surface area, SSA. Here, highly porous carbonaceous nanoparticles were prepared by judicious oxidation of a commercial carbon black (CB) grade (Carbon, 2022: 197, 334-340). X-ray diffraction, N2 adsorption and microscopy analyses revealed that O2 diffuses through, reacts with the bulk CB resulting in tiny pores (Carbon, 2024:219, 118764). The SSA of the oxidized CB obtained here is about 50 - 100 % larger than the SSA of most porous CB grades that are currently available in the market and on par with that of commercial activated carbons used as active material in supercapacitors or electrochemical double layer capacitors (EDLCs). Most importantly, the gravimetric capacitance of EDLCs made using the above high SSA CB is larger than those obtained from EDLCs based on two commercial activated carbons at high scan rates and current densities. The superior rate performance of the present CB is attributed to the large concentration of small pores formed largely by internal oxidation and the small CB particle size (Combust. Flame, 2019: 209, 493-499). Hence, close control of the oxidation dynamics of CB can drastically increase supercapacitor performance.

11CO.4

TiO2 and SiO2 Formation in Corona Discharge Assisted Combustion. CHANAKYA BAGYA RAMESH, Daoru Han, Yang Wang, *University of Miami*

Plasma assisted combustion (PAC) has been proposed as a greener alternative to conventional combustion as it increases flame stability and efficiency, especially during the combustion of low-grade fuels. PAC is different from conventional combustion due to plasma's kinetic, thermal, and hydrodynamic effects on combustion. Due to these effects, PAC may result in very different particle formation mechanisms, thus the physiochemical properties of the combustion-generated particles are expected to be influenced. This study introduced a non-thermal atmospheric pressure plasma (AC corona discharge) into a conventional methane-air premixed flame to understand how plasmas influence particle formation (D_p <10nm) during combustion. Here, we use the particle synthesis precursors TTIP and TEOS (Ti- and Si-based) to study the formation of TiO_2 and SiO_2 during combustion under plasma and non-plasma conditions. For both oxides, cluster formation and subsequent growth are observed to be enhanced up to a certain precursor feed rate. For TiO_2 (up to a feed rate of ~67.7 µmol/hr), the D_p increases by as much as ~43%. For SiO_2 (up to a feed rate of ~288 µmol/hr), the D_p increases by as much as ~9%. Beyond this feed rate threshold, introducing plasma seems to inhibit the formation and growth of particles, with up to ~13% decrease in D_p for TTIP and up to ~20% decrease in D_p for TEOS. This observation suggests that the particle formation and growth mechanism in PAC depends on the concentration and physiochemical properties of ions, which further influence the particles that are formed eventually. It was also seen that these effects were more significant for negatively charged clusters, showing the role of the more mobile charge carriers (e.g., electrons) in such systems.

11CO.5

Toxic Gas and Particle Emissions from Lithium-Ion Battery Fires. XIAOLIANG WANG, Matthew Claassen, Bjoern Bingham, Judith Chow, John Watson, Yan Wang, *Desert Research Institute*

Lithium-ion batteries (LIB) are a ubiquitous component in modern consumer products. However, they pose a considerable safety risk due to their high energy density and toxic ingredients. Furthermore, the cells are at risk of thermal runaway, a process that can lead to rapid and violent combustion. LIB fires pose a catastrophic risk if they occur in enclosed spaces, where combustion emissions cannot be vented, or occupants cannot be evacuated. Such scenarios include LIB fires on spacecraft, aircraft, submersibles, mines, tunnels, or subway systems, where ventilation and evacuation are challenging. Moreover, inhalation of LIB fire smoke is also a health threat to firefighters. It is therefore necessary to properly characterize gas and particle emissions of LIB combustion to understand their health risks and determine the best methods for fire detection, suppression, and clean up.

This study characterized the gas and particle emissions from thermal runaway driven combustion of two LIB types (cylindrical lithium-iron-phosphate [LFP] cells and pouch-type lithium cobalt oxide [LCO] cells), each at five charge levels between 0% and 100%. Emissions from cell venting and flaming combustion were analyzed in real time and collected on filters for subsequent chemical analyses. A large amount of hydrogen fluoride (HF) was released during thermal runaway, sometimes exceeding the immediate danger to life and health (IDLH) concentration limit. Depending on charge level and combustion behavior, the PM2.5 composition was dominated by organic matter (OM), elemental carbon (EC), and/or phosphate. LFP cells had higher emission factors for HF and PM¬2.5 than LCO cells. For HF, the emission factors were 37–77 mg/Wh for LFP and 10–13 mg/Wh for LCO; while for PM2.5, the emission factors were 67–140 mg/Wh for LFP and 35–45 mg/Wh for LCO.

11RM.1

Employing Machine Learning for New Particle Formation Identification and Mechanistic Analysis: Insights from the Six-Year Observation at the Southern Great Plains.

WEIXING HAO, Fan Mei, Tirthankar Chakraborty, Yang Wang, *University of Miami*

New Particle Formation (NPF) is a key factor influencing air quality and climate. Recognizing the important role of NPF in atmospheric processes, this research addresses the gap in automated identification and mechanistic analysis of such events. This study uses machine learning (ML) techniques to identify key atmospheric variables that influence NPF events, including relative humidity (RH), temperature, aerosol surface area, wind direction, wind speed, total organics, sulfur dioxide, and other gas precursors. We aim to elucidate the relationship between these environmental variables and NPF events by using atmospheric and meteorological data. We utilized a comprehensive dataset collected for six years by the Atmospheric Radiation Measurement (ARM) in the Southern Great Plains (SGP) of Oklahoma, USA, and analyzed it with a focus on different seasons and years.

We identified the NPF occurrence using data collected from surface measurements and developed random forest algorithms to determine the relevance of atmospheric variables on the occurrence of NPF events within this data-driven framework. This approach yielded predictions of these events with an accuracy ranging from 90 to 95%. Our results indicated that temperature, RH, and first boundary layer height are the main factors that are associated with the occurrence of NPF, with the normalized variable importance values of 0.32, 0.19, and 0.18. We found that overall, there are higher frequencies of NPF occurrence in spring (35.45%) and winter (42.14%) seasons at the SGP, while the NPF frequency is lower in the summer (4.01%). This study advances the predictive modeling of NPF events for future airborne missions and highlights the effectiveness of ML for studying atmospheric aerosol processes.

11RM.2

Seasonal Investigation of the Factors and Sources Contributing to Ultrafine Particles in the Eastern Amazon Rainforest.

ADAM THOMAS, Deanna Myers, Hayley Glicker, Alex Guenther, James Smith, *University of California, Irvine*

The Amazon basin serves as one of our planet's largest aerosol reservoirs, but the factors and species driving new particle formation in the region are nevertheless not fully understood. Given what is known of the basin's renowned biodiversity as well as the seasonality of its biogenic emissions, it is reasonable to suspect that the sources contributing to particle formation and growth may vary considerably across different subregions and times of the year. Herein we present observations of ultrafine particles (<100 nm in diameter) from studies conducted at the Tapajós National Forest located within the Eastern Amazon, a region with emission profiles and wet/dry seasonality patterns distinct from the more highly studied Central Amazon. We observe that during the transition between the wet and dry season the frequency of new particle growth events decreased, as did the concentrations of particles within these events. Boundary layer height tightly correlated with ultrafine particle concentrations in the wet season (May), but less so into the dry season (July), suggesting different factors are contributing to new particle growth in this period. The molecular composition of ultrafine particles collected in three distinct seasonal periods was analyzed with a high resolution Orbitrap mass spectrometer. With this data, we provide chemical evidence that isoprene organosulfate and monoterpene oxidation chemistries are likely key drivers of ultrafine particle growth in each period observed. In addition, biomass burning likely contributes significantly to ultrafine particle concentrations in drier months (September and December) and biological spore emissions may be an unaccounted secondary source of ultrafine particles in this region during the late wet season (June). Overall, our findings highlight the complexity of factors contributing to particle formation and growth in the Eastern Amazon and suggest that anthropogenic perturbations such as wildfires likely already have a profound influence on these processes.

11RM.3

Upper Tropospheric Particle Formation by Stratospheric Air Intrusion. Jiaoshi Zhang, Xianda Gong, Ewan Crosbie, Glenn Diskin, Karl Froyd, Sam Hall, Agnieszka Kupc, Richard Moore, Jeff Peischl, Andrew Rollins, Joshua P. Schwarz, Michael Shook, Chelsea Thompson, Kirk Ullmann, Christina Williamson, Armin Wisthaler, Lu Xu, Luke Ziemba, Charles Brock, JIAN WANG, *Washington University in St. Louis*

New particle formation (NPF) in the free troposphere is an important source of global CCN, thereby affecting the cloud properties and the Earth’s radiative balance. Over the remote marine atmosphere, NPF has been frequently observed in the outflow region of convective clouds that loft precursors (e.g., dimethyl sulfide) from the boundary layer and remove the pre-existing particles that would otherwise compete with NPF as sinks for condensable vapors. However, several studies suggest that the frequently observed nucleation mode particles in the upper troposphere (UT) are unlikely to be fully explained by NPF associated with convective clouds. In this study, we present observational evidence of NPF in the UT induced by stratospheric air intrusion (SAI), i.e., dynamic descent of stratospheric air into the troposphere, using airborne measurements during the NASA’s North Atlantic Aerosols and Marine Ecosystems Study (NAAMES) and Atmospheric Tomography Mission (ATom). During the SAI events, the mixing of ozone-rich stratospheric air with more moist free tropospheric background leads to increased hydroxyl radical (OH) concentrations. Such mixing is most frequent near the tropopause, where the sulfur dioxide (SO2) mixing ratios are high. The combination of increased SO2 and OH levels results in enhanced sulfuric acid concentrations, thereby promoting NPF. Such NPF occurs frequently and over large geographic regions, likely representing an important particle source in the midlatitude free troposphere.

11RM.4

Small Particle Events over the Southeastern Atlantic Ocean. MARCUS BATISTA, Paquita Zuidema, Yang Wang, *University of Miami*

New particle formation (NPF) is a process consisting of the formation of thermodynamically stable clusters from trace gas molecules, followed by their growth to larger sizes. Globally, NPF contributes significantly to cloud condensation nuclei (CCN) that may further influence cloud formation. Many studies have showed that NPF over the open ocean is unlikely due to the relatively high concentrations of sea spray aerosols, which act as condensation and coagulation sinks. However, recent studies indicate that NPF could occur regularly following the passage of cold fronts [1].

Using data from the Department of Energy`s Layered Atlantic Smoke Interactions with Clouds campaign, we examine aerosol, precursor gas, and meteorological conditions associated with NPF at Ascension Island (ASI; 8S, 14.5W) in the remote southeastern Atlantic marine boundary layer, from June 2016 to October 2017. Based on aerosol size distribution data, we do not observe any events featuring continuous aerosol growth from 10 nm to larger sizes (i.e., the “banana curve”), a typical indicator of NPF. However, we observe episodes where aerosols sized from 15 to 30 nm are transported to ASI, which we refer to as small particle events (SPE). We identified 50 SPE, of which 68% are associated with post-cold frontal open-cell systems. This agrees with recent findings regarding NPF over the open ocean [1].

We find a relatively strong correlation (R = 0.74) between monthly concentrations of particles with sizes below 30 nm and monthly cumulative precipitation, indicating the removal of pre-existing particles as a mechanism for NPF. An association between SPE and vertical velocity, measured by the Doppler Lidar, suggests that recently formed particles were vertically transported to the surface from the upper boundary layer. These vertically transported small particles can grow to sizes relevant to CCN, further contributing to CCN and aerosol-cloud interactions over the Southeastern Atlantic Ocean.

[1] Zheng et al. 2021. Nature Communications, 12(1), p.527.

11RM.5

New Particle Formation in the Kīlauea Volcanic Plume. HANNAH KENAGY, TREX 2023, TREX 2024, Susanne Hering, Jesse Kroll, *Massachusetts Institute of Technology*

Volcanic emissions include primary aerosol particles as well as gases that can contribute to the formation and growth of particles downwind. Here, we explore new particle formation (NPF) in the volcanic plume from Kīlauea on the Island of Hawai'i. We use two condensation particle counters (CPCs) with different size cut-offs to measure the number concentration of ultrafine particles in the plume. Our measurements indicate that NPF events occurred downwind of Kīlauea during both an eruptive period in January 2023 and a non-eruptive period with low-level volcanic SO_2 outgassing in January 2024, and we explore the chemical and meteorological conditions that characterize NPF event days. In addition, through a comparison between CPC and low-cost optical particle counter (OPC) measurements, we explore how OPCs can be used as a probe for NPF events. Finally, we use a low-cost sensor network on the Island of Hawai'i, which includes OPCs, SO_2 sensors, and meteorological sensors, to explore the frequency, timing, and geographic extent of NPF events in the Kīlauea plume.

11SA.1

Chemical Composition and Source-Specific Toxicity of Ambient Particulate Matter in Riyadh, Saudi Arabia. ABDULMALIK ALTUWAYJIRI, Milad Pirhadi, Constantinos Sioutas, *University of Southern California*

In this research, we analyzed the chemical composition and sources of PM10 oxidative potential in Riyadh, Saudi Arabia. We collected time-integrated PM10 filter samples during both dust and non-dust events. These samples were assessed for their content of metals, trace elements, and elemental and organic carbon (EC/OC). We also conducted DCFH and dithiothreitol (DTT) assays to evaluate the oxidative potential of the PM10 samples. Analytical methods including Pearson correlation analysis, principal component analysis (PCA), and multi-linear regression (MLR) were employed to pinpoint the primary sources influencing the toxicity of PM10. Our findings indicated that the oxidative potential of the ambient PM10 samples in this study was notably higher than those reported in many other urban areas globally. According to the MLR results, the predominant sources impacting the oxidative potential of ambient PM10 included soil and resuspended dust emissions (marked by Al, K, Fe, and Li) accounting for 31%, followed by secondary organic aerosol (SOA) formation (indicated by SO4 2- and NH 4+) at 20%, industrial activities (marked by Se and La) at 19%, and traffic emissions (characterized by EC, Zn, and Cu) at 17%. The oxidative potential was greater during dust events than non-dust events, largely due to elevated metal concentrations. This study supports the significant influence of dust emissions on the oxidative potential of ambient PM10 in Riyadh and suggests implications for public health policies to mitigate adverse health effects from PM10 exposure.

11SA.2

Advanced Source Apportionment for the Assessment of Exposure to Exhaust and Non-Exhaust PM in Health Effects Study.

DAVID GREEN, Max Priestman, Anja Tremper, Ian (Gang) Chen, Klea Katsouyanni, Ian Mudway, James Scales, Hajar Hajmohammadi, Helen Wood, Christopher Griffiths, *Imperial College London*

Non-exhaust emissions currently make up a greater proportion of vehicle emissions by mass than exhaust emissions, with the increasing weight of vehicle fleets due to electrification and increasing uptake of larger vehicles it is likely that these will continue to be an increasing health challenge. Here we utilise the high time resolution aerosol measurement instrumentation available at the supersites in London (plus an additional mobile laboratory), coupled to advanced source apportionment techniques to provide source-specific exposure measurements for a randomised cross-over semi-experimental health impact study. It investigated the short-term respiratory health impacts in non-smoking adults with mild-moderate asthma during and after sequential standardised exercise exposures to three contrasting air quality environments, comprising:

(1) A busy road location characterized by stop-go traffic to enhance emissions from brake wear (Marylebone Road)
(2) High speed continuous traffic, to enhance Tyre and Road Wear Particle (TRWP) emissions (White City Roadside)
(3) An urban background location away from nearby traffic sources (Honor Oak Park)

Elemental composition was measured at 1 hourly time resolution using ED-XRF, to maximise size and chemical composition information, PM2.5 and PM10 were collected on alternate hours using a switching valve and intermediate hours are interpolated. An Aerosol Chemical Speciation Monitor (ACSM) measured the non-refractory composition of aerosol and black carbon will be measured using an Aethalometer.

Positive Matrix Factorisation (PMF) was applied to the PM10 and PM2.5 XACT data and ACSM data from all three stations using the Source Finder software (SoFi Pro, https://datalystica.com/) to provide hourly source factor time series and factor profiles for the duration of the exposures. For the ACSM data, this approach has been used in many recent studies to provide high-quality source information using priori information and a bootstrap resampling approach following standardized protocols and is now widely used in source apportionment. PMF of ACSM data yielded typical regional and urban sources of organic aerosol in PM1 and PM2.5. PMF was applied to XACT PM2.5 and PM10-PM2.5 data in single a multi-site analysis to provide consistent factor solutions. A range of regional and local sources were identified, this was achieved by first isolating the roadside increment to provide factor profiles which were then used to constrain PMF for the whole dataset. The analysis of these factors focuses on the non-exhaust and the contrasts between the different locations, vehicle fleet composition and speed.

This work was supported by the US Health Effects Institute funded under RFA 21-1 Quantifying Real-World Impacts of Non-Tailpipe Particulate Matter Emissions, the NERC Traffic Grant (NE/1007806/1) and the NERC OSCA Grant (NE/T001909/2).

11SA.3

Enantiomeric Ratios and Stable Carbon Isotope Analysis of Limonene from Anthropogenic and Biogenic Emission Sources.

SHAN GU, Nana Khundadze, Wentai Luo, Christoph Küppers, Avisa Charmchi, Kevin McWhirter, Todd Rosenstiel, James Pankow, Iulia Gensch, Celia Faiola, *University of California, Irvine*

Volatile chemical product (VCP) emissions have been implicated as a major source of urban air quality degradation. Limonene, in particular, has been identified as a tracer compound for fragranced VCPs in densely populated areas. However, limonene has also been long recognized as a significant emission from terrestrial vegetation. This presents challenges for teasing apart the relative contribution of limonene from anthropogenic VCPs versus biogenic emissions from urban forests in urban areas. Quantifying a limonene "fingerprint” that can distinguish between these different sources would be useful for improving emission inventories and predicting their impact on urban air quality. In this study, (−)/(+)-enantiomers ratios and stable carbon isotope ratios were quantified from limonene emissions of various VCPs and plant sources. Samples were collected on adsorbent cartridges and analyzed offline using thermal desorption gas chromatography mass spectrometry. Chiral GC columns were integral to both methodologies, allowing the baseline separation of (−)/(+)-limonene. A two-dimensional GC and isotope ratio mass spectrometer was used to quantify stable carbon isotope ratios. The results illustrated distinct differences in the enantiomeric ratios and isotopic signature (δ^{13}C) of limonene sourced from VCPs compared to those from tree emissions. (+)-limonene contributed over 97% to total limonene emissions from VCPs with a mean δ^{13}C value of −27.3‰. Conversely, (-)-limonene tends to be more dominant in tree emission sources (with some exceptions) with a mean δ^{13}C of −31.8‰. The difference in δ^{13}C between VCP and real plant limonene sources was statistically significant (p-value<0.01). This indicates that VCP-sourced limonene was enriched in the heavier isotope, possibly due to fractionation during the citrus peel extraction process leading to preferential loss of the lighter isotope. A comparison of outdoor and indoor urban air samples indicates that VCP-sourced limonene is the major source indoors, but outdoor limonene likely originates from a combination of VCP and plant emission sources. Overall, this study demonstrates the potential usage of enantiomeric analysis and stable carbon isotope analysis for improving VCP emission estimates in urban areas.

11SA.4

How COVID-19 Related Policies Reshaped Organic Aerosol Source Contributions in Central London. IAN (GANG) CHEN, Anja Tremper, Max Priestman, Anna Font, David Green, *Imperial College London*

As the largest city in Europe, London is at the forefront of mitigating the health impacts of PM2.5. Knowledge of pollution sources is crucial to design the most cost-effective mitigation strategies. Positive matrix factorization (PMF) of Aerosol Chemical Speciation Monitor (ACSM) data is a powerful approach to quantitatively identify and quantify sources of organic aerosol (OA), which makes up over half of PM2.5. Using the most advanced PMF techniques (i.e., rolling PMF, ME-2, and bootstrap) by following the standardized protocol could provide high-quality source information on OA. The year-long Quadrupole ACSM data from the roadside supersite in London Marylebone Road (51.523 N, -0.155 E) collected from Aug 1st, 2019, to Oct 22nd, 2020, provides us with a unique opportunity to investigate how COVID-related policies impacted human activities and, therefore, OA sources. The period covered the first COVID-19 lockdown (Mar 26th, 2020 to Jun 23rd, 2020) and the Eat Out to Help Out (EOTHO) Scheme (Mon-Wed from Aug 3rd, 2020 to Aug 31st, 2020), which was a British government scheme to support the hospitality industry during COVID-19. Five OA factors were identified including hydrocarbon-like OA (HOA, traffic-related, 10.5% to OA), cooking OA (COA, 19.5%), biomass burning OA (BBOA, 11.5%), more-oxidized oxygenated OA (MO-OOA, 37.7%), and less-oxidized oxygenated OA (LO-OOA, 20.8%). All factors showed distinct diurnal patterns before, during and after lockdown. Moreover, the EOTHO scheme elevated the COA mass concentration after the lockdown by 44.9 % but concentrations remained lower than those observed before lockdown. After the scheme ended, COA concentrations remained. This study suggests special attention should be paid to cooking emissions (8.5% of total PM) in urban environments. Thus, it is important to continuously resolve OA sources to inform policymakers of the effectiveness of the policies.

11SA.5

Understanding the Industrial Aerosol Contribution: Measurements and Modeling. BRIANNA MATTHEWS, Stephen Noble, *Savannah River National Laboratory*

Most environmental pollutants are emitted by anthropogenic activities including industrial processes. To understand the impact from industrial aerosol on climate and human health, industrial aerosol needs to be better characterized. In this study, particles were measured as a proxy for aerosol which includes both particles and gases. Particle concentration and size distribution were measured using a scanning mobility particle sizer (SMPS) approximately 4.5 km from primary industrial areas at the Savannah River Site near Aiken, SC. The SMPS data were divided into two groups depending on the wind direction measured onsite to categorize transport from the industrial area or from elsewhere. Industrial contributions were found to have a higher concentration of particles with sizes less than 200 nm, 844 cm^{-3}, in comparison to non-industrial attributed particles, 734 cm^{-3}. For sizes larger than 200 nm industrial and non-industrial particles have a similar concentration, 86 cm^{-3} and 97 cm^{-3}, with non-industrial concentrations being slightly larger. The difference of 110 cm^{-3} in sizes smaller than 200 nm was attributed to emissions from the industrial areas. Atmospheric dispersion modeling confirmed that particles released at the industrial areas reached the sampling location when the wind direction was favorable for transport from the industrial areas. The industrial particles measured in this study increased concentrations of smaller sized particles that have important implications for climatological impacts including cloud formation and precipitation.

12AC.1

The Effects of Isoprene in Biogenic New Particle Formation in the Presence of SO2. LEE TISZENKEL, Vignesh Vasudevan Geetha, Shanhu Lee, *The University of Alabama in Huntsville*

New particle formation (NPF) from the interactions between biogenic and anthropogenic precursors is responsible for a large portion of atmospheric sub-micron particles. Surveys of the ambient atmosphere have found that NPF seldom occurs when isoprene dominates organic emissions, such as in the southeastern United States or the Amazon. These isoprene-dominant regions are responsible for significant error in NPF modelling due to a lack of comprehensive laboratory data that can explain observations. Previous laboratory investigations of isoprene effects on purely biogenic NPF have found that synergetic effects of isoprene and HOx on monoterpene oxidation contribute to suppression of biogenic NPF. However, pure biogenic nucleation is extremely rare in the real atmosphere due to the ubiquitous presence of anthropogenic pollutants such as sulfur dioxide. We present the results of laboratory studies of isoprene effects on the mixed organic/inorganic system. Particles were produced in a laminar flow reactor from α-pinene oxidation and sulfuric acid. Sulfuric acid was formed in-situ from the reaction of sulfur dioxide with hydroxyl radicals produced from the monoterpene and ozone reaction. Sulfuric acid concentrations were measured with two nitrate CIMS at the beginning and end of the flow tube. Highly-oxidized organic compounds, organosulfates and sulfuric acid clusters were measured with the nitrate HRToF-CIMS at the end of the flow tube. Experiments were done with a fixed α-pinene concentration, with varying sulfuric acid concentration and varying isoprene:α-pinene carbon ratio up to 11, which mimics conditions in the most isoprene-dominant biomes. We found that at sulfuric acid concentrations exceeding 1 pptv, nucleation proceeds at rates similar to purely inorganic nucleation, consistent with previous studies of the mixed organic/inorganic system. At sub-pptv sulfuric acid concentrations, the presence of isoprene suppresses nucleation and growth rates, indicating that biogenic and anthropogenic particle formation processes proceed at similar rates in this regime.

12AC.2

Diurnal and Seasonal Trends of Freshly Nucleated Sulfuric Acid Clusters Observed in Pittsburgh, PA. DOMINIC CASALNUOVO, Darren Cheng, Christine Troller, Coty Jen, *Carnegie Mellon University*

Atmospheric aerosol particles play a crucial role in the Earth's climate by altering the amount of solar radiation reflected or absorbed. A major source of aerosol particles is nucleation, which occurs when gaseous molecules known as nucleation precursors react to form stable particles. These particles can grow into cloud condensation nuclei (CCN) and influence cloud properties such as lifetime and brightness. Previous research shows a major driver of nucleation is sulfuric acid, which forms primarily from the photooxidation of sulfur dioxide. Pittsburgh, PA has a history of high concentrations of sulfur dioxide as local industries emit the pollutant via fossil fuel burning while the valley geography of the region traps it. Previous field campaigns have measured nucleation events in Pittsburgh but did not directly measure sulfuric acid concentrations. To better understand nucleation events happening in Pittsburgh, the Jen Lab measured concentrations of nucleation precursors, composition of sulfuric acid containing nanoclusters, and concentrations of newly formed particles. Measurements were obtained using a nitrate chemical ionization mass spectrometer (CIMS) and a suite of particle instruments. The instruments were deployed during the spring and fall of 2023, during which multiple nucleation events were measured. Freshly formed sulfuric acid-base clusters important to nucleation were identified by relating CIMS-measured clusters to nucleation events. In addition, the CIMS measured high gaseous sulfuric acid concentrations at night. Possible reasons for this phenomenon were investigated using gas monitors and meteorological models. The CIMS and particle measurements contribute to a better understanding of the molecules driving nucleation in Pittsburgh and provide insight into the events seen during previous field campaigns.

12AC.3

Nucleation Closure Study from 2023 Pittsburgh Field Campaign.

DARREN CHENG, Dominic Casalnuovo, Christine Troller, Coty Jen, *Carnegie Mellon University*

Nucleation is the process where gas molecules in the atmosphere react and nucleate to form new particles. Since nucleation produces roughly half of global cloud condensation nuclei, understanding nucleation is important to accurately model Earth's climate. Traditionally, characterizing the nucleation rate first requires identifying a nucleation event, a period where particles at the smallest detectable size appear and grow to larger sizes. Subsequently, the nucleation rate is then calculated over the course of the nucleation event. However, nucleation rates can vary widely during the nucleation event due to differences in atmospheric conditions and the concentration and composition of precursor gases. Nucleation can also occur outside of a well-defined nucleation event. Here, we present a closure study comparing nucleation rates calculated using particle size distribution and gas phase nucleation precursor data. During a field campaign in the Fall of 2023 in Pittsburgh, PA, particle size distributions were measured by the Multi-ANalYzer Condensation Particle Counter (MANY-CPC) and a pair of stepping particle mobility sizers (SMPS). The MANY-CPC provides 1 Hz measurement of the sub-3 nm size distribution and the SMPS from 2 – 300 nm every five minutes. Ambient gas phase composition was measured using a nitrate chemical ionization mass spectrometer (CIMS). The particle-based nucleation rate was calculated using the concentrations of sub-3 nm particles measured by MANY-CPC and the concentration of the condensation sink measured by the SMPS. The precursor-based nucleation rate was calculated using the measured concentration of sulfuric acid and unsteady state nucleation potential model. Our results suggest that near-instantaneous atmospheric nucleation rates can approach the sulfuric acid collision-rate limit during NPF events but only when accounting for the non-ideal detection efficiency of the MANY-CPC. Through these results, we can also differentiate between sulfuric acid-driven nucleation events and nucleation driven by other atmospheric precursors.

12AC.4

Reaction of Methanesulfonic Acid with Multifunctional Amines Used in Carbon Capture and Storage Technologies.

VÉRONIQUE PERRAUD, Patricia M. Morris, Cathy Wong, Paulus Bauer, Colleen Miller, James Smith, Barbara Finlayson-Pitts, *University of California, Irvine*

Although new particle formation (NPF) constitutes an important process in air, there are large uncertainties regarding which species form the first nanoclusters. Acid-base reactions are known to generate new particles, with methanesulfonic acid (MSA) formed from the photooxidation of biogenic organosulfur compounds becoming more important with time relative to sulfuric acid as fossil-fuel related sources of the latter decline. Simultaneously, the use of multifunctional amines in carbon capture and storage (CCS) technologies is expected to result in increased atmospheric concentrations of these bases. Experiments were conducted in a flow reactor coupled to a thermal desorption chemical ionization mass spectrometer (TDCIMS) to examine the NPF potential and the chemical composition of 4-20 nm nanoparticles derived from the reaction of MSA with monoethanolamine (MEA; $NH_2(CH_2)_2OH$), 4-aminobutanol (4AB; $NH_2(CH_2)_4OH$) and putrescine (PUT; $NH_2(CH_2)_4NH_2$). These reactions are even more efficient in nucleating particles than the simple alkylamines, exhibiting the highest nanoparticle formation rates measured to date in MSA systems. Water vapor had only a minimal enhancing effect, in contrast to simple alkylamine reactions. The acid-to-base ratio was close to unity in the range 4-20 nm. This contrasts with MSA reactions with methylamine (CH_3NH_2), where particles smaller than 9 nm were more acidic. The high NPF potential is attributed to the presence of an -OH group on the alkanolamines and an extra $-NH_2$ group for PUT that can participate in H-bonds within the nanoclusters. For comparison, experiments with the corresponding C2 and C4 alkylamines will also be presented. These results highlights that there is no "one-size-fits-all" regarding NPF from MSA reactions with amines, and illustrates the need for studies of more complex amines to fully characterize the NPF potential of this atmospherically relevant strong acid. This work also addresses the potential impact of amines used in CCS technologies.

12AE.1

An Airshed Approach to Mitigating Extreme PM2.5 Levels in India. NEELDIP BARMAN, Lucas Rojas Mendoza, Yuzhou Wang, Srinidhi Balasubramanian, Julian Marshall, Joshua S. Apte, Chandra Venkataraman, *Indian Institute of Technology Bombay*

Ambient fine particulate air pollution (PM2.5) in India is linked to over 1 million annual premature deaths. The Indo-Gangetic Plain (IGP) is home to ~40% of the Indian population and is among the world's most polluted regions due to an interplay of emissions, topography and synoptic meteorology. While India's present air quality policy is strongly city-centric, some researchers and policymakers believe an "airshed"-based approach would be more appropriate and useful than the current city-focused approach.

Here, we exploit the PAVITRA (air Pollution mAnagement and interVentIon Tool foR IndiA) tool, which includes an emissions inventory, disaggregated into 19 economic sectors (SMoG-PAVITRA), and a reduced complexity model for South Asia (InMAP-PAVITRA), to identify dominant states and sectors and their contributions to extreme PM2.5 airsheds within the IGP. We identify and investigate three most-polluted airsheds (northwest-IGP, central-IGP and eastern-IGP) with very high annual PM2.5 concentrations ranging from 60 to 140 ug/m3.

Emissions from six states/union territories (Haryana, Delhi, Uttar Pradesh [UP], Bihar, West Bengal [WB] and Odisha) have the strongest influence on PM2.5 concentrations in the three most-polluted airsheds. PM2.5 concentrations in the northwest-IGP airshed are contributed by emissions from Haryana, Delhi and UP, while central-IGP airshed by Bihar, UP and WB and eastern-IGP by WB and Odisha. Across these influencing states/union territories, PM2.5 concentrations are strongly influenced by emissions from different sectors like residential (Bihar 60%; UP 40%; WB 35%), agriculture (Haryana 20%), diesel vehicles (Haryana 24%; Delhi 30%), energy generation (WB 19%) and MSME (Micro, Small and Medium Enterprises; WB 16%), which also indicate the need for different sectoral interventions for different airsheds. Overall, our findings suggest the need for multi-sector interventions and multi-state cooperation to ameliorate the extreme PM2.5 levels in these three airsheds. The work also identifies a portfolio of interventions that can help India to attain the first World Health Organization interim target of 35 ug/m3 in these extreme PM2.5 airsheds.

12AE.2

PM1 Risk in an Industrial Corridor in Louisiana. BENJAMIN WERDEN, Benjamin A. Nault, Edward Fortner, Ellis Robinson, Amira Yassine, Shivang Agarwal, Mina Tehrani, Andrea Chiger, Carolyn Gigot, Elizabeth Lunny, Joseph Roscioli, Scott Herndon, Tara Yacovitch, Ana Rule, Conner Daube, Thomas Burke, Megan Claflin, Kirsten Koehler, Keeve Nachman, Peter F. DeCarlo, *Johns Hopkins University*

Residents of the Ascension, Iberville, St. James, and St. John the Baptist Parishes between New Orleans and Baton Rouge, Louisiana are disproportionately exposed to industrial pollution including several carcinogens and chemicals linked to other adverse health outcomes. The US EPA has identified this corridor as among those regions with the poorest air quality in the country. To characterize air pollutant sources and their impact on the health of people in surrounding neighborhoods, the Louisiana Hazardous Air Pollutant Monitoring and Assessment Project (LA HAP-MAP) used a mobile laboratory outfitted with a suite of measurements tools with high spatial and temporal resolution to quantity air quality in the industrial corridor in February 2023. The 2023 campaign primarily focused on measurements of known carcinogens, including metals and volatile organic compounds. To quantify the health risks resulting from exposures to particulate matter (PM) in these regions, we sought to understand organic and inorganic aerosol concentrations, size, and chemical composition, with focus on submicron PM_1 species. We measured aerosol components using a soot particle high-resolution time-of-flight aerosol mass spectrometer; these measurements were then processed by positive matrix factorization to determine likely source factors. The observed species and source factors were cross-analyzed with measurement location and wind metrics using mapping tools to determine the likely sources for a variety of aerosol species. We measured air pollutant levels in the study region that could also elicit other non-cancer adverse health outcomes. We use toxicological metrics to convert these aerosol concentrations into estimates of lifetime risks and non-cancer hazards faced by residents of these areas. These measurements and metrics inform the local populations of the local impact of industrial pollution. This knowledge will enable community members and policy makers to understand their risk and activate change.

12AE.3

Characterization of Metals in Communities Surrounding Louisiana's Chemical Corridor During HAP-MAP 2023. AMIRA YASSINE, Mina Tehrani, Edward Fortner, Shivang Agarwal, Ellis Robinson, Benjamin Werden, Benjamin A. Nault, Conner Daube, Megan Claflin, Andrea Chiger, Carolyn Gigot, Manjula Canagaratna, Scott Herndon, Tara Yacovitch, Thomas Burke, Kirsten Koehler, Keeve Nachman, Ana Rule, Peter F. DeCarlo, *Johns Hopkins University*

Inhalation of particulate-bound metals emitted from industrial facilities can pose human health risks. Louisiana's chemical corridor is an 85-mile stretch along the Mississippi River and is one of the most industrialized areas of the US. While it is recognized that facilities here emit metals in aerosol particles, limited quantitative measurements of these pollutants exist. To date, only modeled metals concentrations are available, and these are typically reliant on the facilities' self-reported emissions data. Use of these data may lead to mischaracterization of the true burden of metals exposure; improved spatiotemporal measurements of metals are needed.

During a 4-week sampling campaign in February 2023, size-resolved PM filter measurements were done using a micro-orifice uniform deposit impactor (MOUDI) at a fixed site adjacent to a heavily industrialized waterfront in Louisiana's chemical corridor. The collected filters were later analyzed offline using inductively coupled plasma mass spectrometry (ICP-MS) to determine the concentration of 19 PM bound metals.

ICP-MS measurements showed that the toxic trace metals manganese, arsenic, antimony, and lead concentrations in total PM were higher than EPA-modeled estimates by 85 %,77%, 55%, and 43% respectively. The highest concentrations of lead, vanadium, antimony, and arsenic were within the 0.20 and 0.34 µm PM fractions (which can penetrate deeply into the lungs) (mean concentrations 0.51, 0.44, 0.26, and 0.18 ng/m^3 respectively).

Source apportionment analysis suggested six major metal sources: sea salt, mineral dust, non-exhaust vehicles, and three distinct industrial-related sources (zinc-dominated industrial emissions, industrial activities, and industrial combustion). Toxic trace metals lead, antimony, arsenic, and vanadium were mostly attributed to the industrial combustion factor (their percentages were 99%, 97%, 96%, and 90% correspondingly).

These findings suggest that communities surrounding Louisiana's chemical corridor might be exposed to industrial-related atmospheric metals and metalloids that surpass estimates derived from EPA modeling tools.

12AE.4

Assessment of PM Emissions on Local Air Quality due to Specialty Minerals and Aggregate Processing Industry in a Hispanic/Latino Neighborhood in Brownsville, TX, USA. AMIT U. RAYSONI, Sai Deepak Pinakana, Juan Gonzalez, Gabriel Ibarra-Mejia, Daniel Jaffe, *The University of Texas Rio Grande Valley*

Air quality due to specialty minerals and aggregate processing activities can pose serious health risks to local communities. In the city of Brownsville, Texas, residents in a predominantly Hispanic/Latino neighborhood have raised concerns in the last two years due to high level of dust emissions emanating from a local company that used barite powder to produce products used for animal health and production, oil and gas exploration, and other industrial uses. Barite powder is manufactured from natural barium sulfate ore. Additionally, the hauling of the raw material by eighteen wheelers at all times of the day contributes to heavy vehicular traffic in the neighborhood.

Consequently, a research endeavor was undertaken to install low-cost Purple Air sensors in three households in the neighborhood. The houses were chosen such that a vertical transect (roughly 375 ft, 650 ft, and 1275 ft) was obtained from the company. The sensors were installed outside the houses. Outdoor air quality data was collected for four months (December 23 – April 24). Additionally, indoor air data was collected for a few weeks each at two of the houses. The indoor monitoring involved the installation of a Purple Air Sensor, and two FEM monitors i.e., GRIMM - Model 11-D - Dust Decoder - Portable Aerosol Spectrometer and TSI DustTrak™ DRX Aerosol Monitor to investigate the infiltration of dust from the outdoor environment into indoors. All the low-cost sensors used were also collocated with FEM monitors to improve accuracy. The PM (both PM2.5 and PM10) data obtained from the study will be compared with the only Texas Commission on Environmental Quality (TCEQ) Central Ambient Monitoring Site (CAMS) station in the city of Brownsville, which is located in a salubrious and green leafy neighborhood. This research study also focuses on the important issue of environmental justice in this part of the U.S.-Mexico Border Region.

12CC.1

The Role of Organic Nitrogen for Aerosol Solubility, Phase Separation and CCN Activity. NAHIN FERDOUSI, Kotiba A. Malek, Kanishk Gohil, Kiran Reddy Pitta, Tim Raymond, Dabrina Dutcher, Miriam Freedman, Akua Asa-Awuku, *University of Maryland, College Park*

Aerosols are present as complex organic-inorganic mixtures within our atmosphere; and under certain conditions can exist with phase separated morphology. When submicron aerosols are exposed to supersaturated conditions (>100% RH), the water uptake ability of the aerosols vary based on the composition of the mixture. The hygroscopicity of complex mixtures presenting liquid -liquid phase separation LLPS was previously studied through the measurement of CCN activity within a 2-methylglutaric (2-MGA)/ammonium sulfate (AS) binary system and a 2-MGA/AS/sucrose ternary system; both studies correlated water-uptake abilities to O/C and surface tension. However, little is known about the influence of solubility of the third component on phase separation of a ternary mixture containing 2-MGA/AS. The water-uptake properties of mixtures containing nitrogen containing compounds, such as amino acids, are not well defined. Therefore, it is undetermined if O/C alone is an acceptable parameter for the estimation of solubility and hygroscopicity of complex amino acid mixtures. To improve our understanding of LLPS within aerosol mixtures and factors influencing its presence, three ternary systems were studied – a leucine system (2-MGA/AS/Leu), valine system (2-MGA/AS/Val), and proline system (2-MGA/AS/Pro). For each system, the CCN activity of mixture compositions with varying O/C ratios and compositions was measured using a Cloud Condensation Nuclei Counter (CCNC) from 0.3 to 1.5% supersaturation (SS). For all mixtures, the single hygroscopic parameter κ was calculated. Experimental κ results were compared against four theoretical models; three of the theoretical models included were Köhler theory, O/C LLPS with surface tension (O/C LLPS-ST) and a newly developed model, X/C LLPS with surface tension (X/C LLPS-ST). For this study, a new parameter considering O/C and nitrogen to carbon (N/C), X/C, was introduced as a parameterization for solubility. The O/C LLPS-ST model was adapted to consider X/C for subsequent estimations of κ. A fourth theoretical model took a weighted average of the O/C LLPS-ST and X/C LLPS-ST models. Each model provides insight into the complex nature of aerosol mixtures and subsequent droplet growth. Thus, this provides an improved understanding of organic nitrogen-containing aerosol mixtures' water uptake abilities through the introduction of new coupled parameter models. As a result, the study is able to show varied N/C contribution to the system based on the structure of the amino acid as well as a method to improve current abilities to predict hygroscopicity of these complex, nitrogen-containing aerosol mixtures.

12CC.2

Quantifying the Effects of Phase State on the Ice Nucleation Abilities of Organic Aerosols. Xiaohan Li, Martin Wolf, Xiaoli Shen, Isabelle Steinke, Zhenli Lai, Sining Niu, Swarup China, ManishKumar Shrivastava, Zhenfa Zhang, Avram Gold, Jason Surratt, Daniel Cziczo, Susannah Burrows, YUE ZHANG, *Texas A&M University*

Organic aerosols (SOA) may serve as deposition ice-nucleating particles (INPs) and impact the formation and properties of cirrus clouds when their phase state and viscosity are in the semi-solid to glassy range. However, there is a lack of direct parameterization between aerosol viscosity and their ice nucleation capabilities.

In this study, we experimentally measured the ice nucleation abilities of 2-methyltetrol aerosol particles, a key component of the isoprene-derived secondary organic aerosols (SOA), as a function of aerosol viscosity to examine the effects of phase state on ice nucleation. A kinetic parameterization based on classical nucleation theory is mathematically developed based on experimental data, connecting the physicochemical properties of organic aerosols with their ice nucleation abilities.

Our parameterization not only quantify the effects of viscosity on the heterogeneous nucleation rate, but also revealing that viscosity has a significant impact on the ice nucleation abilities of SOA at typical cirrus cloud conditions, leading to 2 to 3 orders of magnitude differences in the ice nucleation rate from the liquid state to the semi-solid state. Additionally, based on data collected from a previous field study and this parameterization, we have shown that the INP concentration from SOA can reach up to 10 L^{-1} in the cirrus cloud region in the upper troposphere above the Amazon rainforest. Our study highlight the potential importance of organic aerosols in the heterogeneous ice nucleation process, with parameterizations that can be applied in regional and global climate models to further improve understandings of cirrus cloud formation and climate prediction.

12CC.3

Arctic Ice Fog: Unveiling the Role of Aerosol Chemistry. NURUN NAHAR LATA, Ismail Gultepe, Harindra Joseph Fernando, Darielle Dexheimer, Zezhen Cheng, Fan Mei, Swarup China, *Pacific Northwest National Laboratory*

Arctic ice fog (IF) is a meteorological phenomenon characterized by cold air temperatures (Ta) and suspended ice crystals (<200 µm) in the lower atmosphere, reducing visibility to less than 1 km. Despite its prevalence, the effects of IF on the Arctic climate are poorly understood. IF impacts traffic, human safety, ecosystems, and local weather by reducing visibility and causing light snow (LSN) precipitation. Associated with high-latitude boundary layer mixed-phase clouds, IF's evolution and properties are poorly known. To address this gap, we conducted aerosol sampling during IF, light-blowing snow (LSN), and cloudy conditions at the U.S. Department of Energy Atmospheric Radiation Measurement Program's facility at Oliktok Point, Alaska, in the IFFExO (Ice Fog Field Experiment at Oliktok Point).

Aerosols were collected using the Size and Time-resolved Aerosol Collector (STAC) and cascade impactors on ARM's Tethered Balloon System (TBS). Samples were analyzed using multimodal microscopy and spectroscopic techniques, covering particle sizes ranging from 0.12 to 5 µm. Chemical analysis revealed variations in size-resolved composition between IF and non-IF (NIF) periods. IF samples were characterized by a higher fraction of sulfate and carbonaceous particles with lower organic volume fractions (OVF<20% and 20-40%). In contrast, LSN and cloudy/foggy samples contained more Na-rich and carbonaceous particles with higher organic volume fraction, OVF~60-80%. This suggests that ice nuclei (IN) leading to IF crystal nucleation likely originated from solid sulfate and carbonaceous particles. The physicochemical properties of IF-processed aerosols offer valuable information for IF prediction and to better evaluate the lifecycle of high-level ice clouds. This study provides critical insights into IF particle chemistry and formation mechanisms, improving our understanding of IF processes and their impacts on weather and climate simulations, and informing strategies for mitigating IF-related challenges in the Arctic region and cold climates.

12CC.4

Hygroscopicity Prediction Impacted by Particle Mixing in Sub-urban Environment (HIMS). SHRAVAN DESHMUKH, Laurent Poulain, Birgit Wehner, Silvia Henning, Jean-Eudes Petit, Olivier Favez, Hartmut Herrmann, Mira L. Pöhlker, *Leibniz Institute for Tropospheric Research, Leipzig,Germany*

Hygroscopicity and particle mixing state strongly influence aerosol properties and multiphase chemistry, which plays an essential role in estimating the direct radiative effect of aerosols on Earth's climate. Although CCN (cloud condensation nuclei) properties are commonly measured, sub-saturation hygroscopicity measurements remain rare. Within the ACROSS campaign, which took place in the Paris region, France, during the summer of 2022, the particle's hygroscopic growth at 90 % relative humidity (RH) and chemical composition were concurrently measured at sub-urban site SIRTA using a Hygroscopicity Tandem Differential Mobility Analyser (HTDMA) and Aerodyne High-Resolution Time-of-Flight Aerosol Mass Spectrometer (HR-ToF-AMS) respectively.

The growth factor probability density function (GF-PDF) revealed two distinct modes—hydrophobic and hygroscopic—suggesting a combination of internal and external particle mixing. The prevalence of the hygroscopic mode increased with particle size, as reflected in the averaged values of hygroscopicity. The classical Zdanovskii-Stokes-Robinson (ZSR) mixing rule was applied (Stokes and Robinson 1966) to the chemical composition to make accurate quantitative predictions of the mean GF of atmospheric aerosol. The closure between measured and chemical-derived hygroscopicity is approximately 50% for 100nm particle size, but this level of agreement is not observed for 250nm. Our study found that chemically derived mean growth factor values do not accurately identify the growth factors of multiple modes. Furthermore, this approach proves unreliable in predicting the wide spread of growth for aerosol particles that are externally mixed. The mixing state of aerosol strongly influences the prediction of the aerosol hygroscopicity. Whereas during this measurement, 80-90% of particles were externally mixed and influenced by fresh emission, which impacted the prediction of the hygroscopicity by a factor of 2. These findings highlight the complex interplay between aerosol properties, chemical composition, and atmospheric processes, providing valuable insights for future research. Moreover, laboratory studies are conducted on pure chemical compounds to develop new hygroscopicity prediction method.

12CM.1

The Potential Efficacy of Double Masking. PETER CHEA, Buddhi Pushpawela, Ryan X. Ward, Richard Flagan, *California Institute of Technology*

Double masking generally decreases the penetration of particles and increases the pressure drop compared to the individual mask. When we wear the two masks the outer mask provides pressure to the edges of the inner mask, and therefore the inner mask fits more closely to the face and creates a better seal and an additional layer of protection. During the COVID-19 pandemic, the Centers for Disease Control and Prevention (CDC) and health experts recommended double masking to improve protection. However, the performance of double masks related to their particle penetration, pressure drops (breathing resistance or comfort), type of the masks, and combinations was limited in the literature. To address these limitations, we measured and compared the particle penetration and pressure drop of single and double masks (6 different combinations) that were fully sealed at a steady flow rate of 30 LPM. Of the double masks tested, N95 + procedure masks, N95 + cloth masks, KN95 + procedure masks, KN95 + cloth masks, and procedure + cloth masks showed 3-5% penetration, comparable with that of the N95s. The pressure drop measured for different double mask combinations varied between 38 and 83 Pa. These pressure drop values agreed well with the theoretical pressure drops estimated by the sum of the respective pressure drop values of single masks. The combination of procedure and cloth masks had similar pressure drops and penetration performance to a single respirator, making this double mask combination adequate in situations where respirators are less cost-effective or in limited supply. Therefore, the results of this study offer information to the community about the proper mask combinations that provide more protection than the individual mask.

12CM.2

Airborne Transmission and Mitigation in Indoor Environment: Insights from the COVID-19 Pandemic. Sunil Kumar, Meiyi Zhang, JOHN CATE, Hunter Welch, Maria King, *Texas A&M University*

The infrastructure of the global health system was disturbed by the COVID-19 pandemic. Due to the virus's rapid spread, nations were forced to implement lockdowns, restrict travel, restrict industrial output, and shut down supply networks in order to stop the coronavirus from spreading. But the virus's widespread dissemination led to a high number of hospital admissions for patients in need of moderate to critical care. Compared to other well-known surface deposition modes, it was discovered that the infectious virus was primarily propagating through the air. The development of air flow patterns in the presence of exhaust and diffusers determines the transmission of viruses via the air, particularly in interior environments. Large-volume facilities, like assembly rooms, packaging rooms, and meat production rooms, are nevertheless extremely critical when equipped with a traditional HVAC system. The lengthy and complex air streams that ventilation ports produce have the ability to spread the virus from one area of the food processing facility to another. A single sneeze from an asymptomatic employee in such an environment might possibly distribute the virus droplets throughout the entire facility, making it a super spreader for the community. Effective contamination control and elimination of contaminated droplets are necessary for a safer indoor environment. Therefore, to stop the virus from spreading, air flow pattern design alterations are required. This study presents research that assesses the impact of installing a transparent separation between workers. The long-range air streamlines that could carry viruses from one place to another were mitigated by the placement of partitions. These barriers prevent virus-loaded droplets from spreading in local surroundings. The study maximizes droplet containment by optimizing partition design. Any industry can use the findings of this study, regardless of size or nature of job.

12CM.3

PIV Characterization of a Large-Scale EHD Vortex Confinement Flow in a Wire-to-plate ESP for Electrostatic Particle Clustering.

SANJAY DANGI, Eric Monsu Lee, *Northern Illinois University*

With the increased use of nanoparticles and micro-plastic-based products, the concentration of PM_{10} has increased in the biosphere due to the disposal of manufacturing waste and expired parts. If inhaled, these fine particles can result in detrimental health effects as they can travel deep into our lungs and even penetrate blood vessels. Filters for indoor air quality control exhibit drawbacks, including periodic filter replacement, and high-pressure drop across the filter demanding increased power consumption with time. At power plants, electrostatic precipitators (ESPs) are predominantly used to collect fly ash with more than 99% collection efficiency. However, for submicron particles collection efficiency drops significantly due to low particle charging rate. The movement of particles in the ESPs depends on the electric field, ion density, inlet velocity, particle properties, electrode geometry, and the electrohydrodynamic (EHD) flow. At corona onset, large-scale EHD vortex flow can be induced due to discontinuity in ion density. This large-scale EHD vortex flow can affect the collective behavior of the submicron particles and has not been extensively characterized. The flow has previously been studied with a 2-D axisymmetric model but has not been experimentally confirmed. This study aims to confirm the large-scale EHD vortex flow by developing a wire-to-plate ESP for particle entrainment. The EHD flows with different EHD/Re^2 numbers will be measured by using Particle Image Velocimetry (PIV) seeded by DEHS particles (avg. $d_p \sim 1\mu m$). Two counter-rotating large-scale vortex flows near the tips of the electrodes are expected to be observed, potentially confining the DEHS particles and leading to electrostatic particle clustering.

12CM.4

Reduction of Aerosols Generated from the Dental Handpiece.

Ting-Yin Ji, Chih-Yung Wu, Yung-Chung Chen, Chun-Juei Chou, MING-YENG LIN, *National Cheng Kung University*

During dental treatment using the dental handpiece, a high concentration of aerosol is generated. This can have serious health implications with prolonged exposure. Moreover, water mist generated from the dental handpiece can also cause discomfort among patients and health workers. While current solutions like local exhaust ventilation (LEV) are effective, they can be bulky and inconvenient. Our proposal offers a promising alternative-the use of an air curtain for dental aerosol and water mist control. This innovative approach, the first of its kind, could potentially revolutionize dental aerosol and water mist reduction, making it more efficient and user-friendly.

We will first use Particle Image Velocimetry (PIV) to monitor the flow field and aerosol reduction efficiency under different parameters, such as the opening width and flow rate of the air curtain device. We then use MATLAB image processing to evaluate the aerosol and water mist reduction efficiency. Preliminary results indicate that adding an air curtain can help confine over 70% of the dental aerosol and water mist. This novel device will not only help reduce dental aerosol and water mist but also make future dental visits more comfortable and safe for both patients and health workers.

12CO.1

Utilizing Fire Radiative Energy to Predict Organic Carbon and Elemental Carbon Emissions from Burns under Simulated Prescribed-fire and Wildfire Conditions. ROBERT PENLAND, Chase Glenn, Omar El Hajj, Anita Anosike, Kruthika Kumar, Steven Flanagan, Mac A. Callaham, E. Louise Loudermilk, Joseph O'Brien, Rawad Saleh, *University of Georgia*

The Georgia Wildland-fire Simulation Experiment (G-WISE) involved performing burn experiments of fuel beds collected from 3 ecoregions in the Southeastern U.S.: Piedmont, Coastal Plain, and Blue Ridge. The Blue Ridge fuel bed contained surface fuels (fine and woody) and a duff layer, while the others contained surface fuels only. The fuels were conditioned to moisture contents representative of either prescribed fires (Rx) or drought-induced wildfires (Wild). Here, we present elemental carbon (EC) and organic carbon (OC) emissions and how they correlate with fire radiative energy (FRE) and FRE normalized by fuel mass loading (FRE_{norm}).

For burns that involved ignition of surface fuels only, fuel consumption was linearly correlated with FRE (R-square = 0.90). However, burns that involved duff ignition fell outside the correlation (lower FRE for the same fuel consumption), indicating that duff exhibits less efficient combustion than surface fuels. Whereas OC emissions were linearly correlated with FRE for all burns (R-square = 0.73), EC emissions were linearly correlated with FRE (R-square = 0.72) for burns that involved ignition of surface fuels only. Again, burns that that involved duff ignition fell outside the correlation (lower EC emissions for the same FRE). EC/OC ratio was linearly correlated with FRE_{norm} (R-square = 0.57), indicating that FRE_{norm} is a practical metric for combustion conditions. FRE_{norm} (and EC/OC) was lowest for burns that involved duff ignition. For burns that involved ignition of surface fuels only, FRE_{norm} was lower for Rx compared to Wild.

Overall, these findings signify the importance of both moisture content and existence of duff in dictating combustion conditions and consequently, OC and EC emissions. Furthermore, the findings demonstrate the utility of FRE and FRE_{norm} to determine OC and EC emissions, which can be applied in top-down emission inventories that rely on FRE retrievals from satellite observations.

12CO.2

Comparative Assessment of Organic Aerosols from Biomass Combustion Based on Controlled Laboratory Studies vs Field Studies Using the Example of Sugar Cane Combustion. Elena Hartner, THOMAS GRÖGER, Nadine Gawlitta, Sandra Piel, Hendryk Czech, Genna-Leigh Geldenhuys, Jürgen Orasche, Petri Tiitta, Pasi Yli-Pirilä, Miika Kortelainen, Patricia Forbes, Olli Sippula, Thomas Adam, Ralf Zimmermann, *Helmholtz Zentrum München and University of Rostock*

Agricultural biomass combustion aerosols, particularly biomass-burning organic aerosols (BBOA), represent a significant global aerosol source. Controlled burning practices, such as those employed in sugar cane harvesting to manage surplus biomass, contribute substantially to this aerosol burden. While regulatory measures have been implemented to mitigate risks to workers and local communities, these burnings still exert substantial impacts on human health, the environment, and the climate, both regionally and globally.

Understanding the aerosol formation resulting from such fires necessitates either controlled laboratory investigations or field measurements during actual burning events. This study aims to evaluate the comparability of findings from these approaches through direct comparison. Field experiments involved authentic open-field burning conducted at five distinct sugar cane farms in South Africa. Additionally, controlled laboratory experiments, simulating sugar cane burning, were conducted in batches using dried sugar cane leaves sourced from the same origin. These experiments were carried out at the aerosol physics, chemistry, and toxicology research unit (ILMARI) of the University of Eastern Finland.

Aerosol sampling was conducted using quartz fiber filters, adsorber tubes, and portable multichannel polydimethylsiloxane denuders. Analytical techniques, including one and comprehensive two-dimensional gas chromatography mass spectrometry, were employed to assess the chemical composition of the collected samples. Chemical fingerprints obtained were analyzed using targeted and nontargeted approaches.

Both experimental setups revealed a complex chemical composition of biomass combustion emissions, encompassing compounds originating from the pyrolysis of (hemi)cellulose and lignin. Notably, field experiments detected additional organic compounds such as pyridine and oxime derivatives, methoxyphenols, methoxybenzenes, and triterpenoids. In contrast, laboratory experiments only partially replicated the complexity observed in real combustion events.

The results highlight disparities between field and laboratory experiments, attributed to differences in combustion conditions, fuel composition, and atmospheric processing. These findings underscore the importance of considering such factors when interpreting results and designing future studies in this field.

12CO.3

Controlling Factors for Smoke Emissions from Urban and Wildland Fuels.

CHRISTIAN CARRICO, John Ryan Himes, Sabina Gulick, Allison Aiken, Katherine Benedict, Kyle Gorkowski, James E. Lee, Alexander Josephson, Jon Reisner, Manvendra Dubey, *New Mexico Institute of Mining and Technology*

Air quality and climate change concerns drive an increased importance of aerosol emissions from wildland and urban fuels. Recent fires in grasslands and the wildland-urban interface (WUI) such as the Camp, Lahaina, Texas Panhandle, and Marshall fires, underscore the importance of fires in these transitional landscapes. Wildland fire studies here have focused upon U.S. native and invasive species as well as common urban fuels as controlling factors in smoke properties. This research focuses on key aerosol combustion sources including grassland fires at the Konza Prairie in Kansas and emissions from urban fuels measured at the New Mexico Firefighter Training Academy. Key measurements include laboratory, drone-based, and ground-based techniques. Drone-based measurements include air quality sensors to measure $PM_{2.5}$ properties including mass concentrations (PurpleAir and similar sensors) and light absorption and its wavelength dependence (micro-aethalometer). Complementary measurements from the ground include aerosol optical depth, filter-based $PM_{2.5}$ measurements, CO and CO_2, aerosol hygroscopicity, and meteorological data. Transitory wildfire nature and shifts in the combustion phase as indicated by the Modified Combustion Efficiency (MCE) are clearly observed influencing the dominance of black versus brown carbon aerosols. The field measurements echo some of the key findings of laboratory studies of biomass burning emissions and provide some new insights into the evolving nature of fires in the WUI. Measurement highlights from the field sites as well as laboratory experiments with smoke and its proxies will be discussed.

12CO.4

In-Field Emissions from Pellet-Fed Gasifier Stoves in Urban Zambia.

Stephanie Parsons, ANDREW GRIESHOP, *North Carolina State University*

In Zambia, 76% of the urban population still relies on charcoal for cooking. A private stove distribution company in Zambia is co-developing (with a Swedish engineering company) a forced-draft, pellet-fed gasifier stove, the SupaMoto, an ultra-low-emission biomass stove to minimize health and climate impacts of cooking. To evaluate real-world emission performance, we conducted 48 uncontrolled cooking tests of SupaMoto prototypes and traditional charcoal stoves, measuring carbon monoxide (CO), black carbon (BC), real-time particle light scattering, fine particulate matter ($PM_{2.5}$), elemental carbon (EC), and organic carbon (OC). The prototype SupaMotos were tested by cooks who typically use a similar, commercially available pellet gasifier stove. CO emission factors (EFs) of SupaMoto stoves (4.7 g kg^{-1}) were on average 98% lower than those of charcoal stoves (226 g kg^{-1}), consistent with the “best” tier (Tier 5 in the laboratory-based ISO targets) of cookstove emissions. Mean PM EFs for SupaMoto (1.0 g kg^{-1}) were 43% lower than charcoal stoves (1.8 g kg^{-1}). EC EFs from SupaMoto stoves (0.35 g kg^{-1}) were higher than those of charcoal stoves (0.21 g kg^{-1}); however, real-time data show that most BC emissions occurred during startup, and SupaMoto tests ignited with kindling had BC EFs 2.5 times higher than those ignited with kerosene. Poor startup performance and misapplication of a ‘top plate’ diffuser during tests was also associated with high PM emission events and elevated EFs. Analysis of various stove use metrics collected by the stove vendor (e.g., pellet purchases, time since stove purchase, hours of stove use measured by on-board sensors) indicated a weak to moderate anticorrelation between level of user experience and test EFs, suggesting user experience is a determinant of emissions. Finally, we conduct analysis suggesting that substantial net climate benefits would result from the widespread adoption of the SupaMoto.

12RM.1

New Methodology for Deriving Super-micron Sea Salt Aerosol Number and Flux Values Using Doppler Lidar Measurements.

Tyas Pujiastuti, NICHOLAS MESKHIDZE, Markus Petters, *North Carolina State University*

Previous studies have shown that super-micron sea salt aerosols (SSA) can impact cloud microphysical properties and induce drizzle and warm rain formation in stratocumulus clouds. Despite their importance, our knowledge of super-micron SSA particle fluxes, vertical distribution, production mechanisms, and spatiotemporal distribution in the marine boundary layer remains limited. Here we report measurements of remotely sensed size-selected (with ambient diameter between 1 and 10 µm) particle number concentration and production flux. The data were collected during the Eastern Pacific Cloud Aerosol Precipitation Experiment (EPCAPE) campaign at Scripps Pier, La Jolla, California, from 15 April to 30 September 2023. The aerosol size distribution was acquired from surface measurements by an optical particle counter, and vertical profiles of vertical velocity and attenuated backscatter were obtained from a Doppler lidar. The data were reduced for cloud-free conditions with onshore winds ≥ 4 m s^{-1}.

By combining super-micron aerosol number size distributions measured at the pier with the Mie theory-calculated relationship between particle number concentration and backscatter, we derived the super-micron (plausibly SSA) number concentration and size distribution at 105 m height (minimum usable range for the Doppler lidar) above the ocean surface. The derived number concentration ranged from 0.3 to 1.6 cm-3, and the production flux (calculated using the Eddy Covariance method) ranged from 0.1 cm^{-2} s^{-1} to 1.25 cm^{-2} s^{-1} for different surface wind speeds. The size-selected fluxes exhibited a pattern similar to the size distribution. The highest flux was derived for 1.02 µm particles and declined exponentially for the larger sizes. The particle number concentrations and derived fluxes are comparable with the available SSA parameterizations. This presentation will discuss how this novel methodology based on remotely-sensed data for deriving size-selected super-micron aerosol number concentration and production flux values can be applied over different ocean regions.

12RM.2

Strongly Absorbing Aerosol Refractive Indices in the Highly Polluted Indo-Gangetic Plains.

TAVEEN KAPOOR, Harish C Phuleria, Benjamin Sumlin, Nishit Shetty, Gupta Anurag, Mahak Bansal, Sandeep Duhan, Shahzar Khan, Jitender Laura, Pooja Manwani, Rajan K. Chakrabarty, Chandra Venkataraman, *Washington University in St. Louis*

The Indo-Gangetic plains in India experience prolonged periods of poor air quality and haze during the post-monsoon and winter months. Large aerosol emissions and unfavorable meteorological conditions combine to lead to this phenomenon. However, little is understood about the nature of aerosol optical properties and their relation to chemical composition over the region, which ultimately determines their climate impacts. In this study, we measured the wintertime aerosol optical properties at Rohtak, a regionally representative site in the Indo-Gangetic plains. We measured the real-time aerosol absorption coefficients, scattering coefficients and particle number size distribution. These measurements were used to calculate the aerosol effective refractive index (inverted using the PyMieScatt Python package), the first report of this property in the region. Aerosol particles were collected on filter substrates and used to estimate the $PM_{2.5}$ and thermo-optically fractionated total carbon concentrations. $PM_{2.5}$ concentrations of 163 µg/m^3 with a relatively high EC/OC ratio revealed that the aerosol particles are likely strongly absorbing in nature, corroborated by the measured small single-scatter albedos (0.7) and large imaginary refractive index (~0.1). This imaginary (absorbing) refractive index (~0.1) was at the higher end of previous measurements of the same property in the ambient atmosphere. Further, strong absorption strengths in the mid-visible wavelengths, implied the presence of BrC constituents, estimated to contribute to ~32% of the near-UV aerosol absorption. The imaginary refractive index positively correlated with brown carbon (BrC) absorption contribution, revealing BrC dominance on aerosol absorption. Strong correlations between the organic and elemental carbon fractions and the predominance of thermal fractions of organic carbon (OC3 and OC4), reveals that BrC constituents likely originated from primary combustion sources and had substantial contributions from low-volatility compounds. Through a brief comparison with climate model simulated properties, we show that the strongly absorbing nature of the aerosol is not simulated well by the climate models. The present study's findings could help improve the accuracy of climate modelling simulations that underestimate aerosol absorption and extinction in the region.

12RM.3

Biomass Burning Black Carbon Properties during the G-WISE Campaign using the Single Particle Soot Photometer (SP2). JOHN ALLEN, Ryan Poland, Zachary McQueen, Dongli Wang, Andrew Metcalf, Joseph O'Brien, Rawad Saleh, Geoffrey Smith, *University of Georgia*

The Single Particle Soot Photometer (SP2) is used to measure black carbon (BC) concentrations and the mixing state of individual particles using laser-induced incandescence and scattering signals (Stephens et al. 2003). The SP2 was employed at the Georgia WIldland-fire Simulation Experiment (G-WISE), a multidisciplinary campaign in which fuel beds from three different eco-regions of Georgia (Piedmont, Coastal Plain, and Blue Ridge) were burned to simulate wild (lower fuel moisture content) and prescribed (higher fuel moisture content) fires. Here, we use measurements of the “delay time” between the peak of BC incandescence and the peak of scattering to infer the relative coating thickness (Moteki and Kondo, 2007) for the different fuel beds and moisture contents and use a thermodenuder in tandem with the SP2 to infer coating volatility. We then use these techniques to also study the effect of oxidative aging on the BC coatings by exposing BC to oxidants through an oxidative flow reactor. Aging increases the delay time for particles from all fuel beds indicating thicker coatings. A comparison of delay times with and without the thermodenuder demonstrates that a substantial fraction of the coatings evaporates from Blue Ridge particles, whereas very little appears to evaporate from Coastal Plain particles, indicating a difference in coating volatility for particles generated from these two types of fuel beds. The Blue Ridge fuel contains duff, decaying organic material with high moisture content (Zhang et al. 2022), while Coastal Plain does not. The additional burning of duff provided particles generated Blue Ridge with different organic material to form coating contributing to the observed higher volatility.

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12RM.4

Aerosol Properties, Origins, and Impacts within Complex Mountainous Terrain in the Upper Colorado River Basin. ALLISON AIKEN, Abu Sayeed Md Shawon, Katherine Benedict, Leah Gibson, Paul DeMott, Sonia Kreidenweis, James Smith, Jiwen Fan, Jessie Creamean, Russell Perkins, Darielle Dexheimer, Swarup China, Fan Mei, Gregory W. Vandergrift, Zezhen Cheng, Daniel Feldman, *Los Alamos National Laboratory*

Aerosols are central to understanding surface-atmosphere exchanges and the water cycle within mountainous regions due to aerosol-cloud-precipitation interactions. Since they are distributed vertically within the column, they can impact large-scale circulation, precipitation, and land-atmosphere interactions. For these reasons, it is important to know the physical and optical properties, but also chemical composition to understand their lifecycles and influence within an integrated mountain hydroclimate. We report aerosol properties observed during the U.S. Department of Energy’s Surface Atmosphere Integrated field Laboratory (SAIL) campaign, a 21-month deployment (September 2021 - June 2023) of the Atmospheric Radiation Measurement (ARM) Facility in the Upper Colorado River Basin near Crested Butte, Colorado. The Aerosol Observing System (AOS) collected a comprehensive suite of aerosol measurements on Crested Butte Mountain while the Tethered Balloon System (TBS) collected data vertically within the boundary layer during different seasons. We also deployed specialized instrumentation from LANL to measure bioaerosol and supermicron particles. Based on the chemical composition of aerosols collected at SAIL, we found that most of the aerosols were organic, indicating the importance of local and regional biology and ecosystems for controlling the limited numbers of aerosols in the domain. At the SAIL sites which ranged from 9,500 ft asl to 10,291 ft asl, the average mass concentration of PM10 was <10 ug/m3 with submicron number concentrations <100 #/cc and organics <2 ug/m3 measured at the higher elevation site. Black carbon was <15 ng/m3 indicating little impact from combustion sources and aerosol were mostly scattering with single-scattering albedos (SSA’s) of ~0.9. Transient events that significantly depart from background conditions due to transported biomass burning, urban combustion and dust (during snow-covered periods) increased PM10 aerosol concentrations up to as high as ~200 ug/m3 as occurred in April 2023 and lasted hours to days will also be presented.