Plenary I: AEESP Lecture

Low-cost Sensors for Exposure and Health Science: How It Started, How It's Going. JOHN VOLCKENS, *Colorado State University*

Over the past decade, low-cost sensor technologies have become widely popular for quantifying outdoor levels of fine particulate matter. The size, cost, and connectedness of these technologies, along with a renaissance of data science, have enabled measurements at unprecedented scale: from the personal level (what are YOU breathing in?) to a global network of connected devices (e.g., PurpleAir). With air pollution now recognized as the leading environmental cause for premature disease and death across the planet, the need for monitoring is greater than ever. As a result, these sensors show promise for enhancing public health research and practice, whether it be for exposure monitoring, epidemiology, environmental justice, or citizen science. Their application in resource-limited environments is a particularly attractive feature.

The rapid rise of low-cost sensor technologies brings questions about utility, performance and reliability, the future of R&D in this space, and their place in the research community. This plenary will review the state-of-the science of low-cost aerosol sensors (and related technologies), with a focus on public and environmental health. I will discuss their history, their strengths & limitations, their use and misuse, and their prospects for enabling research and discovery in support of public health in the 21st century. I will cover topics ranging from Mie scattering and optics, to global health and air pollution-related disease, calibration, personal exposure, precision medicine, market forces, microelectronics, machine learning, memes, and more!

Plenary II

Nonlinear Trajectory: From Aerosol Science to Environmental Public Health. SARAH HENDERSON, *British Columbia Centre for Disease Control*

Exposure to ambient particulate matter (PM) has a profound effect on the health of populations. Short-term exposure is associated with a growing list of acute health outcomes, and long-term exposure is associated with a growing list of chronic health outcomes. There seems to be no facet of human health unaffected by our air quality. The available evidence has been the impetus for drastically reducing PM emissions from sources such as vehicles and industry, but we are facing different threats as the climate changes. Smoke from wildfires is starting to dominate lifetime exposures to PM in many regions, and some jurisdictions have identified biomass fuels as climate-friendly energy sources.

The day-to-day work of environmental public health entails the synthesis, translation, and mobilization of scientific evidence into the sphere of policy and practice. Consider the example of wildfire smoke. Every year we learn more about this complex and dynamic form of air pollution from multiple disciplines: aerosol science; atmospheric science; landscape ecology; toxicology; immunology; clinical research; observational epidemiology; implementation science; and many more. The role of environmental public health is to take all of this information and digest it in response to one overarching question: what do people need to know about wildfire smoke, its health effects, and how to protect themselves?

The trajectory from aerosol science to environmental public health is nonlinear. While we all have different roles to play in reducing the harms caused by PM pollution, we are all united by the fact that our combined work **can** reduce these significant and modifiable harms. This talk will help aerosol researchers better understand the field of public health and better communicate their work to this key stakeholder group.

Plenary III: Friedlander Lecture

The Secret Lives of Filters. JEFFREY SIEGEL, *University of Toronto*

Improving indoor air requires addressing source control, ventilation, and filtration. There is an implicit hierarchy in these measures and a long history surrounding the importance of source control and ventilation, even though source control is often not possible, and ventilation is limited by ambient air pollution. Filtration is a much newer approach that has received much less attention. Part of this arises from the fact that filters are often viewed as static with performance solely determined by efficiency as a function of particle size. However, filters are dynamic as the filter efficiency curve of the same filter will change depending on the application as well as over the filter lifetime. Further, filter performance is often largely a function of the context of how the filter is used as much as the filter itself. This presentation explores filter performance from both aerosol science and building science perspectives with a focus on how theoretical and laboratory-tested filtration efficiencies translate to filtration performance in real buildings. The removal of particulate matter is only part of the filtration story. Filters also have a variety of secondary consequences including emissions of gas-phase compounds and complicated impacts on energy use. These effects need to be considered in overall considerations about filter use. However, some of these secondary effects may have a positive impact, including the ability of filters to offer insight on air quality through filter forensics, the analysis of the particles that accumulate on the filter. Several examples of filter forensics for disease surveillance, exposure assessment, and ambient air quality are used to illustrate the hidden value in used filters. The COVID-19 pandemic has further increased the attention paid to central and portable filtration in buildings and this presentation assesses new challenges and opportunities that arise from this renewed focus.

Plenary IV

AAAR's First 40 Years: Its Origins and Evolution. SUSANNE HERING, David Ensor, *Aerosol Dynamics Inc.*

At the time AAAR was founded in 1982, the term “aerosol” was most often used by the lay public to refer to a spray can – whether it be hair spray or insect repellent. Now, 40 years later, a greater fraction of the public understands the term “aerosol” to mean fine airborne particles that can act as a pathway for transmission of respiratory disease, and even as a type of air pollutant.

Aerosol technology emerged from an unrecognized field to an important discipline during the latter half of the twentieth century. In 1960 the US Atomic Energy Commission (now subsumed into DOE) created the Inhalation Toxicology Research Institute to study late-occurring health risks from inhaling small amounts of radioactive particles. In 1970s the State of California funded the “Aerosol Characterization Experiment”, an expansive field experiment to unravel the science, and sources of the visibility-reducing smogs in Los Angeles. Around the same time the military’s interest in obscuration smokes for lasers led the development of an aerosol research program at the Edgewood Chemical Biological Center. Critical advances were made in aerosol instrumentation including automated condensation particle counters, single particle optical counters and the electrical mobility analyzer.

At this time, aerosol research was published in a number of journals, and presented at a variety of conferences. Kenneth Whitby’s famous work on the multimodal nature of Los Angeles smog was first presented at an American Chemical Society Symposium and published in the *Journal of Colloid and Interface Science*. Other papers appeared in *Atmospheric Environment*, and *Environmental Science and Technology*. 1970 saw the birth of the *Journal of Aerosol Science*, published by Pergamon Press under the editorship of C.N. Davies. In the US, conference presentations were spread between annual meetings of the Air Pollution Control Association, the American Chemical Society, and American Institute of Chemical Engineers (AIChE), supplemented by a few less formal meetings including the Aerosol Technology Meetings, and the Edgewood Aerosol Conferences. Aerosol science was a growing field in Europe as well, with annual aerosol meetings at the University of Mainz and at Battelle-Frankfurt, leading to the formation of the Gesellschaft fur Aerosol Forschung in 1972. Yet in the US there was no common home.

We think of professional organizations starting first, and then producing a journal. For AAAR the order was the opposite. AAAR was founded to support its journal. In 1978 David Shaw published not one, but two, books on aerosol science and technology based on an aerosol symposium held under the auspices of the AIChE. Given his success, Elsevier Science Publishing Co. approached him to start an aerosol journal. If there were to be a journal, it was decided there needed to be a professional organization behind it. The decision to form AAAR was made by Sheldon Friedlander, David Ensor, Benjamin Liu and David Shaw at a meeting held in Research Triangle Park, NC in the fall of 1981. Our first conference was held the following February in Santa Monica, CA, with 300 attendees. The first abstract submitted to that conference came from David Sinclair, for whom the AAAR Sinclair Award is named. The first issue of our journal, *Aerosol Science and Technology*, appeared that same year, directed by its founding editors, Ensor, Liu and Shaw.

In the early years, AAAR was run through the volunteer efforts of its leading members. In the ensuing period, as the AAAR grew, it adopted a formal structure, with codified by-laws, governing procedures and management. Likewise, the journal evolved, driven by the vision of its editors, increasing its scope and presence. Throughout its forty years, the traditions of AAAR and its journal continue to be driven by dedicated volunteers within its membership.

1AC.1

Exploring the Chemical Evolution of Aerosol Particle Composition and Physical Properties using Single Particle Levitation. RAVLEEN KAUR KOHLI, James F. Davies, *University of California, Riverside*

In the atmosphere, aerosol particles become transformed by various heterogeneous reactions that alter their physical properties and chemical composition. Consequently, these transformations regulate the dynamics of aerosols and ultimately have a significant impact on the atmospheric role of these particles. A major area of focus in present day atmospheric research is to understand and predict how aerosol particles evolve due to heterogeneous oxidation reactions with ozone (O3) and radicals, such as OH· as the oxidants. This has led to extensive explorations of their physical and chemical properties through the development of various single particle and ensemble measurement techniques.

In this work, I discuss the development of an experimental platform that couples a linear quadrupole electrodynamic balance (LQ-EDB) with electrospray ionization - mass spectrometry (ESI-MS) through an open port sampling interface (OPSI) for exploring single levitated particles undergoing chemical evolution. We have demonstrated the effectiveness of this approach towards the qualitative and quantitative analysis of single particles containing a range of atmospherically relevant compounds (Kaur Kohli et al., Anal. Chem., 2022). Measurements were made on the evaporation dynamics of chemically evolving multi-component organic droplets containing a range of small n-ethylene (n=3, 4 and 6) glycols. The measured compositional evolution was shown to be consistent with the evolving size using a simple multicomponent evaporation model (Kaur Kohli et al., Anal. Chem., 2021).

Here, we apply the combined LQ-EDB-ESI-MS methodology to simulate heterogeneous reactions happening in atmosphere, such as ozonolysis, on single levitated particles and precisely measure their physical and optical properties as a function of their evolving composition during the reaction. The results provide important insights on how oxidative aging of ambient aerosol particles influences their physicochemical characteristics by understanding reaction kinetics based on the phase state, degree of oxidation, and new product formation.

1AC.2

Modeling of the Atmospheric Process of Cyanobacterial Toxins in Algal Aerosol. VICTORIA ZORBAS, Myoseon Jang, *University of Florida*

Fresh water aerosol enriched in cyanobacterial toxins is produced by breaking waves and bursting bubbles in lakes and estuaries. In this study, the determination of the longevity of toxins in the ambient air is assessed by the development of the Harmful Algal Aerosol Reaction (HAAR) model, which is a kinetic model for predicting the atmospheric process of toxin via heterogeneous reactions of the cyanobacterial microcystins (MCs) with the atmospheric oxidants. Typically, the conjugated alkene of the β-amino acid (ADDA) in MCs reacts with atmospheric oxidants such as O3 and OH radicals. The process of cyanobacterial aerosol and toxins in both daytime and nighttime is observed in a large outdoor photochemical smog reactor (UF-APHOR). The rate constant of the nighttime ozonolysis of MC-LR in algal aerosol is semi empirically estimated by using chamber data at a given gaseous ozone concentration and Henry's law constant based on a pseudo-first order reaction approach. The MC-LR concentrations are measured using a conventional enzyme-linked immunosorbent assay (ELISA) and compared to data from LC-MS-MS. The water content in cyanobacterial algal aerosol is measured by using a Fourier Transform Infrared Spectrometer and applied to the HAAR model to simulate impact of humidity on the MC-LR decay. The degradation of MC-LR during daytime is faster due to the involvement of the reaction of the conjugated double bond in ADDA with both atmospheric ozone and OH radicals. The daytime degradation of MC-LR in algal aerosol is performed during the photooxidation of 2-methyl-2-butene in the presence of NOx. The simulated degradation of MC-LR in cyanobacterial algal aerosol is compared to experimental data that are performed under varying conditions in the UF-APHOR chamber.

1AC.3

The Peroxy Radical Fates during Heterogeneous Oxidation of Organic Aerosols. WEN ZHANG, Chuanyang Shen, Haofei Zhang, *University of California, Riverside*

The heterogeneous oxidation of organic aerosols (OA) in the atmosphere can have a great impact on the air quality, climate, and human health. In previous studies of heterogeneous chemistry, flow tube reactors are commonly used as the tool to study the kinetics and aging mechanisms, which create an environment with high OH concentrations ([•OH]) and short reaction time (τ, seconds to a few minutes), to mimic the OH exposure level (= [•OH] × τ) in the real atmosphere. Through these traditional studies, the main heterogeneous mechanisms were found to be peroxy radical (RO2•) centered chemistry including RO2• self-reactions to form an alcohol-carbonyl pair or two alkoxy radicals (RO•). However, it remains unclear whether [•OH] and τ are exchangeable. In this work, we perform •OH-initiated heterogeneous oxidation of OA model systems in a continuous flow stirred tank reactor (CFSTR) to bring the OA heterogeneous oxidation from typical laboratory [•OH] much closer to ambient levels. Besides, we also control the gas-phase concentrations of HO2 and NO to study their reactions with RO2• during the heterogeneous oxidation. The aging kinetics of OA systems and their product composition are measured in real time using a thermal desorption chemical ionization mass spectrometer (TD-CIMS) with iodide as the reagent ion. An offline ion mobility spectrometry mass spectrometer (IMS-MS) with electrospray ionization is used for an isomer-resolved characterization of oxidized OA systems. Using this experimental setup and instruments, we can explore new reaction pathways centered on interfacial RO2• and study aerosol heterogeneous kinetics under conditions that are closer to the real atmosphere.

1AC.4

Photosensitized Aging of Secondary Organic Aerosol by Nitrophenols. AVERY DALTON, Maggie Chou, Sergey Nizkorodov, *University of California, Irvine*

Nitrophenols are a class of aromatic organic compounds that have gained much interest because of their intercontinental environmental presence. Atmospheric sources include both primary sources, such as automobile engines and biomass burning, and secondary sources, by reactions between phenols and NO2/NO3 radicals. An important piece to the evolution of nitrophenols is their presence in gaseous, aqueous, and organic particle phases, providing a wide variety of possible chemistries. This work aims to investigate the influence of nitrophenols on the photodegradation of secondary organic aerosol (SOA). Preliminary results indicate that 2-nitrophenol, which is well known to lose HONO from photolysis, is significantly more resistant to photodegredation in an organic matrix than in the aqueous phase. While the photochemical lifetimes of nitrophenols are relatively long, generally on the order of multiple days, they could also sustain indirect photochemistry by acting as photosensitizers. To test this hypothesis photochemistry experiments are conducted with a quartz-crystal microbalance (QCM) to monitor SOA mass loss rates and the results will be compared to SOA samples without nitrophenols present. We anticipate that the presence of these nitrophenols will accelerate the photodegradation of SOA, particularly in SOA which does not nominally absorb at tropospherically relevant wavelengths.

1AC.5

Nitration Reactions of Proteins in Urban Air: O3 and NO2 Concentrations, Exposure Time, and Implications. RACHEL L. DAVEY, Erick Mattson, J. Alex Huffman, *University of Denver*

Exposure of proteins to atmospheric oxidants like ozone (O_3) and nitrogen dioxide (NO_2) can induce chemical modification, like the formation of nitrotyrosine (NTyr). Proteins with these modifications have been shown to promote adverse human health effects, such as exacerbation of allergies and respiratory disease. Pollen can rupture upon exposure to air pollutants or humidity, releasing cytoplasmic material like allergenic proteins into the atmosphere. These proteins could then undergo heterogenous reactions with pollutants to produce chemically modified proteins, which then can negatively impact human health. To investigate the protein modification process under ambient reaction conditions, bovine serum albumin (BSA), as an inexpensive protein model, and ragweed pollen protein (Amb) were exposed to urban air at two sites in Denver, Colorado for varying lengths of exposure time over the course of two years. NTyr formation in BSA, measured as nitration degree (ND) using high-performance liquid chromatography, was correlated with O_3 and NO_2 concentrations, as well as relative humidity, temperature, and exposure time. Previous laboratory experiments observed ND values of BSA as high as 12%, based on the number of exposed tyrosine residues. The urban site with higher NO_2 and lower O_3 concentrations (<30 and 50 ppb) resulted in ND values between 0-5%, whereas the suburban site with lower NO_2 and higher O_3 concentrations (<20 and 70 ppb) generally resulted in even higher ND values, up to 9%. These observations are consistent with the mechanism proposed via laboratory experiments but had not been shown using ambient exposure. Insight learned from this study has implications for other aerosol chemical mechanisms, such as reactions with other proteins, free amino acids, and polycyclic aromatic hydrocarbons that are subject to chemical reactions in the atmosphere, as well as potentially to indoor environments that produce NO_2.

1AC.6

Aqueous-Phase Autoxidation of Organic Compounds: Study on Fate and Detection of Organic Peroxides. TANIA GAUTAM, Lisa Ng, Ran Zhao, *University of Alberta*

Autoxidation is known to cause food rancidity, cellular degradation and deterioration of petroleum fuels. Gas-phase autoxidation mechanisms occur via successive H-abstractions by peroxy radicals and subsequent O_2 addition. Organic peroxides are a major fraction of secondary organic aerosols (SOA) and serve as reservoirs of HO_x and RO_x radicals. They are also key reaction intermediates arising from autooxidation. Currently, there is a lack of evidence on autoxidation in atmospheric aqueous phases (e.g., cloudwater). Organic peroxides can help resolve the intricacies behind aqueous-phase autoxidation mechanisms. Yet, the detection of peroxides remains elusive due to their labile nature and a lack of selective analytical technique. Our goal is to study novel aqueous-phase autooxidation mechanisms using advanced analytical techniques and probe the stability and chemistry of intermediate organic peroxides. In particular, aqueous-phase autoxidation mechanism was investigated for the first time by evidencing the formation of products containing multiple hydroperoxide groups. Photooxidation experiments were performed on laboratory simulated cloudwater constituting model compounds: 7-octenoic acid (7-OE), 3-octenoic acid (3-OE), limononic acid (LA) and benzoic acid (BNA). The C=C bond in olefins provides molecular specificity to OH initiated mechanisms, assisting our elucidation of mechanisms. To monitor peroxides, offline and online analyses were performed with iodometry assisted (-)ESI/HPLC-MS and (+)APCI-MS respectively. Successful identification of peroxides and their corresponding alcohol products was achieved via redox chemistry of iodometry. Time-resolved evolution of second generation peroxide species was achieved via direct-injection MS. In particular, (+)APCI-MS^2 on ammonium-peroxide adducts was utilized. Systematically designed experiments revealed susceptibility of peroxides towards elevated temperatures (25, 50 and 80°C), photolytic (254 nm) and time-dependent (0-24 hr) measurements. Our results provide an intuitive approach for the first ever verification of aqueous phase autoxidation mechanism. The fundamental knowledge gleaned from our study can assist in understanding rapid transformations of organic peroxides in the aqueous phase.

1AC.7

Aging of Secondary Organic Aerosols at Atmospherically Relevant Acidities.

CYNTHIA WONG, Sergey Nizkorodov, *University of California, Irvine*

The acidity of atmospheric aerosols spans a wide range, with the most acidic particles having negative pH values, which can promote acid-catalyzed reactions. Many reactions in the atmosphere are pH-sensitive including, hemiacetal and acetal formation, hydration of complex aldehydes, ketones and carbonyls, aldol condensation, esterification, and epoxide protonation. However, the impact of highly acidic conditions on aerosol chemical composition and aging processes remains uncertain. Our previous experiments investigated the aging of SOA in a bulk H_2SO_4 solution, whereas this work focuses on our ongoing work, wherein an aliquot of sulfuric acid is dispersed in a small amount of SOA to achieve a more relevant H_2SO_4:SOA ratio in order to elucidate mechanisms of acid-catalyzed aging of mixtures of SOA compounds. SOA samples were generated in a continuous flow reactor and collected onto quartz windows. A small aliquot of aqueous sulfuric acid, ranging in concentration, was added and pressed between the quartz window with SOA and a clean quartz window. The sample was then aged for 2 days and then extract using a 1:1 mixture of water and acetonitrile. Analysis of fresh and aged samples was conducted using ultra-liquid chromatography coupled with a photodiode array spectrophotometer and a high-resolution mass spectrometer to study the change in the chemical composition of SOA before and after aging. We found that SOA aged in highly acidic conditions resulted in a change in the chemical composition, including the formation of sulfur-containing compounds. The findings from this study will improve our understanding of SOA aging processes in the upper troposphere and lower stratosphere and highly polluted areas where there are significant contributions of sulfates and high acidity.

1AE.1

Characterization of VOC and Particle Emissions in Exhaled Air during Vaping.

KATHERINE HOPSTOCK, Donald Blake, Sergey Nizkorodov, Rufus Edwards, *University of California, Irvine*

Electronic nicotine delivery systems (ENDS) usage has steadily risen in popularity, predominantly amongst the youth, due to likely posing a lower health risk than traditional tobacco products. Despite this, there are gaps in knowledge on the hazards of second-hand exposure to exhaled breath emissions. Harmful compounds from direct exposure (inhaled vape stream) have previously been identified, however, the constituents of exhaled aerosol (particulate and vapor phase) have not been assessed. Using a Proton Transfer Reaction Time-of-Flight Mass Spectrometer (PTR-ToF-MS) and a Scanning Mobility Particle Sizer (SMPS), we have directly characterized the chemical composition and particle size of fresh exhaled vape emissions and inhaled vape stream. Flavor profiles (mint, watermelon, vanilla, apple, and mango) were varied amongst 5 repeat participant visits to test if major changes in gas-phase chemical composition would occur. Human volunteers' puff topography was measured and utilized in concentration calculations. Notable compounds of health relevance recorded by PTR-ToF-MS present in e-cigarette vapor included formaldehyde, acrolein, butene, acetone, propanal, dimethyl sulfide, and nicotine. The data is consistent with previous suggestions that the majority of inhaled compounds deposit in the lungs with high efficiency regardless of the flavor type.

1AE.2

Personal Exposure of Domestic Dogs and Their Owners to Airborne Per- and Polyfluoroalkyl Substances (PFAS). EMILY JOHNSON, Maryam Aniya Khalili, Elizabeth Lin, Jeremy Koelmel, Shelly L. Miller, Krystal Godri Pollitt, *Yale University*

Per- and polyfluoroalkyl substances (PFAS) have gained attention given their prevalence and persistence in the environment and in our bodies. PFAS have been detected in water, food products, and consumer products. Furthermore, companion animals may be exposed to elevated PFAS levels due to sources from pet products as well as household items. A growing number of studies have been conducted to better understand the toxicological and public health impacts of legacy PFAS resulting from ingestion and dermal exposure pathways in both humans and domesticated animals. As alternative replacement PFAS emerge in the market, these compounds are shorter chain which allows them to be volatilized more readily into the air, introducing a need to study the inhalation exposure. The objective of this study was to determine PFAS personal exposures of humans and dogs and perform a comparative assessment of the two populations using wearable passive samplers. Fresh Air samplers, consisting of custom-made polydimethylsiloxane sorbent bars sheltered in a housing case, were deployed in wristbands and dog collars for seven consecutive days within a cohort of 38 dog-human pairs in Boulder, Colorado. Collected samplers were analyzed following the assessment period using thermal desorption gas chromatography high-resolution Orbitrap mass-spectrometry. Across the 21 PFAS assessed, 7 compounds were detected. The greatest exposure range was observed for 1H,1H,2H,2H,3H,3H-perfluoroundecyl acetate while the highest exposure concentrations were for FTOH 10:2, FTOH 12:2, and FTOH 14:2. Detected PFAS were highly correlated for dog-owner pairs suggesting similar sources of exposure within the home environment. Our findings demonstrate the utility of wearable passive samplers to assess personal exposure to airborne PFAS. Application of these sampling tools with domestic animals and humans presents opportunities to understand exposures of concern alongside public health implications for pet owners and their animals.

1AE.3

Toxicological Impact of Secondary Organic Aerosol Compounds in Air-Liquid-Interface Exposed Lung Cell Models. Svenja Offer, Elena Hartner, Thomas Gröger, Yinon Rudich, Michal Prado, Astrid Kiendler-Scharr, Thorsten Hohaus, Andreas Paul, Sebastiano di Bucchianico, Martin Sklorz, Hendryk Czech, RALF ZIMMERMANN, *Helmholtz Zentrum München and University of Rostock*

In the framework of the aeroHEALTH Helmholtz International Lab, the impact of atmospheric aging on health effects is elucidated. We investigated differences in toxicological effects of Secondary Organic Aerosols (SOA) generated by photochemically aging of a biogenic (β-pinene) or an anthropogenic (naphthalene) organic precursor with combustion-derived soot particles (SP) as seed in two different lung cell models exposed at the air-liquid interface (ALI). Lung epithelial cell monocultures (A549) and a co-culture model (A549 and EA.hy926-endothelial cells) were exposed at the ALI for 4 h to different aerosol concentrations of pure SP (CAST), β-pinene-SOA on SP ($SOA_{\beta PIN}$-SP) or naphthalene-SOA (SOA_{NAP}-SP) on SP. The aerosols were comprehensively characterized (physical/chemical properties) and toxicity tests were conducted to determine cytotoxicity, intracellular oxidative stress, genotoxicity, inflammatory effects etc. in the models (Offer et al, EHP 2022). Both investigated SOA-types caused significant toxicological effects. The toxicological assays furthermore indicated greater adverse effects of SOA_{NAP}-SP compared with $SOA_{\beta PIN}$-SP in both cell models. At functional level SOA_{NAP}-SP augments the secretion of e.g. malondialdehyde and interleukin-8, inducing an activation of endothelial cells (co-culture), confirmed e.g. by comet assay suggesting secondary genotoxicity. Chemical characterization of PM revealed distinct differences in the composition of the two secondary aerosol types. It is shown that SOA-compounds can increase the toxicity of primary SP, which are ubiquitous in inhabited and wildfire influenced areas. Aromatic precursors, such as naphthalene caused the formation more oxidized, more aromatic SOA of higher oxidation potential with higher toxicity compared to an aliphatic precursors, such as β-pinene. The influence of atmospheric chemistry on the chemical PM composition play a crucial role for the adverse health-outcomes of emissions. Further comparable experiments have been conducted with CAST soot aerosols (ultrafine particles) with different chemical composition (high/low content of polycyclic aromatic hydrocarbons) and with real emissions (e.g. fresh and photochemical aged car emissions).

1AE.4

Air Pollution Constituents that Influence the Frequency and Severity of Children's Asthma Exacerbations. JONATHAN THORNBURG, *RTI International*

Asthma exacerbations are responsible for 1.8 million emergency room visits and 0.4 million hospitalizations in the USA each year, constituting a major public health problem and economic burden. We measured personal exposure to air pollution in a cohort of exacerbation prone asthmatic children (n = 120, pre-COVID) in Denver, Colorado. Our goal is to identify the air pollution constituents that influence exacerbation frequency and severity. The personal and indoor exposure measures included PM10 mass concentration and black carbon (BC), tobacco smoke (ETS), and brown carbon (BrC) measured by the MicroPEM; NO2 and O3 concentrations from Ogawa passive samplers; and allergens from questionnaires. Exhaled nitric oxide (FeNO), spirometry, and CASI score assessed lung inflammation. Personal-indoor pollutant correlations followed established trends: personal PM10 greater than indoor and weakly correlated whereas personal-indoor NO2 levels are strongly correlated. Mean PM10 and ETS exposures did not vary by season. BC was higher in the winter and BrC was lower in spring compared to other seasons. The hourly average PM10 concentrations demonstrated seasonal variations, especially in the magnitude of peak exposures. Peak PM10 exposures always occurred in the afternoon or evening with fall > summer = winter > spring. From the surveys, the presence of a dog in the home was associated with greater allergic inflammation and asthma severity. Preliminary analyses suggest personal PM10 and NO2 concentrations, but not indoor, are associated with higher FeNO. Final air pollution exposure and asthma severity associations will be presented.

1AE.5

Measurement and Speciation of Ultrafine Particles Generated by Small Electric Motors. GARY CASUCCIO, Traci Lersch, Kristin Bunker, Scott Hollenbeck, John Jankovic, Tracy Zontek, *RJ Lee Group, Inc.*

Laboratory experiments were performed in a test chamber to evaluate the emissions of particulate matter emitted from small electric motors used in commercial products such as hair dryers and vacuum cleaners. The test chamber was designed to contain the electric motor and sampling apparatus. Particulate concentrations (p/cm3) and particle size distribution from 10 nm to 600 nm were measured using a scanning mobility particle sizer (SMPS). A thermophoretic particle sampler was used to collect airborne ultrafine particulate directly on an electron microscope grid, which was analyzed using electron microscopy (EM) techniques including computer controlled scanning electron microscopy (CCSEM). EM and CCSEM analyses provided information on particle characteristics including morphology, elemental composition, particle size distribution and particle concentration (p/cm3). The particle concentration and size distribution from the CCSEM analysis for the electron motor emissions analyzed were similar to the SMPS results. The electron microscopy results indicated that emissions were primarily composed of copper and carbon particles.

1AE.6

Contributing to the Mechanistic Understanding of Asthma Development: Allergenic and Inflammatory Cell Response from Exposure to Salton Sea Derived Aerosol. RYAN W. DROVER, Trevor Biddle, Mia R. Maltz, Qi Li, Daniel Gonzalez, David D. Lo, David R. Cocker III, *University of California, Riverside*

The Salton Sea is a rapidly drying endorheic body of water in California's Riverside and Imperial counties. This retreat of the water level has led to continuously increasing exposure of playa, a significant source of PM10 as dust in the area. In the aqueous environment, the drying and addition of toxins has resulted in increasing salinity, algal blooms, and overall toxicity, contributing to the die-off of fish and migratory birds. Alongside these environmental issues, a public health crisis has developed in communities that experience one of the highest asthma rates in California (20-22.4%. vs. 14.5% California statewide) and are among the highest rates of hospitalization for asthma in the state.

The dual 540 L whole-body animal (mouse) exposure chambers have been used to measure pulmonary responses distinct from allergic inflammation from Salton Sea-sourced aerosol, with comparative exposure studies conducted using aerosolized Pacific Ocean water and fungal allergen (Alternaria). This work includes 48-hour and 7-day mouse exposures conducted with aerosol produced from Salton Sea playa and seasonally-collected dust from passive dust collectors, as well as lipoteichoic acid (LTA) from Staphylococcus aureus and lipopolysaccharide (LPS) from Escherichia coli. The exposure target concentrations were determined based on levels that promoted inflammatory cell recruitment without an accompany cytokine storm (1, 15, and 150 ug/m3 for LTA and LPS, 750 ug/m3 for Alternaria, and 1500 ug/m3 for Salton Sea environmental samples). Differential responses were measured for allergic and immune response, including neutrophil and eosinophil recruitment and gene expression changes. Salton Sea material from different sources were found to produce different responses in exposed mice, contributing to our mechanistic understanding of the particular asthma developed in the region.

1AE.7

Developing National Exposure Models for Source-Specific Primary Particulate Matter Concentrations Using Aerosol Mass Spectrometry Data. PROVAT SAHA, Albert A. Presto, Steven Hankey, Benjamin Murphy, Julian Marshall, Allen Robinson, *Carnegie Mellon University*

In this study, we investigate the feasibility of developing national empirical models to predict ambient concentrations of sparsely monitored air pollutants at high spatial resolution. We measured cooking organic aerosol (COA) and hydrocarbon-like organic aerosol (HOA; traffic primary organic PM) using High-Resolution Aerosol Mass Spectrometry (HR-AMS) in twelve states, eleven cities, and eleven sub-urban/remote locations across the continental US. To characterize intra-urban spatial patterns we performed high-resolution mobile monitoring in three cities. The monitoring locations were carefully selected to span the national distribution of land-use and source-activity covariates commonly used for land-use regression models (e.g. road length, restaurant count, etc.). Empirical models developed through supervised linear regression select predictor variables that are physically meaningful. Restaurant density and commercial land use-related variables are important predictors for the spatial variability of COA. Transportation and urbanicity-related variables are important predictors for the spatial variability of HOA. Extensive cross-validation suggests the models are robust with reasonable transferability. The models predict large urban-rural and intra-urban variability with hotspots in urban areas and along the road corridors. The predicted national concentration surfaces show a reasonable spatial correlation with source-specific national chemical transport model (CTM: CMAQ) simulations. The measured data, empirical models, and CTM predictions all show that cooking emitted primary organic aerosol concentrations are higher than traffic primary organic aerosol. This highlights the potential importance of controlling commercial cooking emissions for air quality management in the US.

1BC.1 (Invited)

(Not) Burning Down the House: Investigating the Fate of wildfire Smoke in Homes. DELPHINE K. FARMER, Kathryn Mayer, Liora Mael, Lauren A. Garofalo, Jienan Li, Katelyn Rediger, Michael Link, Dustin Poppendieck, Marina Vance, *Colorado State University*

Wildfires are increasing in both intensity and frequency across the western United States, and people across the region are experiencing increased wildfire smoke outdoors and inside their own homes. The mechanisms by which smoke particles and gases transform when they move and age inside a building are poorly constrained. The Chemical Assessment of Surfaces and Air (CASA) study took place at the Net Zero Energy Residential Test Facility at NIST in Gaithersburg, MD. CASA included repeated experiments in which either fresh or aged smoke was injected directly into the house. The smoke was allowed to transport and transform throughout the house; experimental perturbations included the addition of ozone, the presence of high levels of relative humidity (75% vs 30% RH), and the use of various air cleaning devices. Measurements included aerosol composition by high resolution aerosol mass spectrometry, size distribution from the ultrafine through coarse modes, gas-phase organic compounds by various chemical ionization mass spectrometry measurements, and an array of surface measurements. This presentation will provide an overview of these experiments, and how they inform our understanding of wildfire smoke chemistry and mitigation in the indoor environment.

1BC.2

The Chemistry of Wildfire Smoke in the Indoor Environment during the CASA Campaign. KATHRYN MAYER, Jienan Li, Lauren A. Garofalo, Liora Mael, Andrew Martin, Michael Link, Dustin Poppendieck, Marina Vance, Delphine K. Farmer, *Colorado State University*

Climate change and land management practices have resulted in increasing numbers of severe wildfires over the last several decades in the US, which in turn negatively affect air quality for millions of people. Due to the negative health effects associated with wildfire smoke, officials generally recommended that people stay inside during smoke events; however, very little is known about how wildfire emissions affect indoor air quality. During the Chemical Assessment of Surfaces and Air (CASA) campaign, we studied the chemical transformation of wildfire smoke in a 4,100 ft^2 (380 m^2) test house located at the National Institute of Standards and Technology. Briefly, ponderosa pine wood was burned as a proxy for wildfire smoke and injected into the test house, which has an air change rate of ~0.24 hr^{-1}. Experiments included injections of fresh smoke, as well as smoke that had been aged by exposure to ozone. The chemical and physical properties of the smoke were monitored using a suite of instruments, including a high-resolution aerosol mass spectrometer (HR-ToF-AMS), which measures size-resolved submicron non-refractory aerosol composition. In addition, sub- and supermicron aerosol size distributions and black carbon concentrations were measured, as well as a suite of gas-phase measurements. Preliminary findings suggest that there are significant differences between the chemistry of fresh and aged smoke. Future results will explore the fate and chemical evolution of wildfire smoke in the indoor environment.

1BC.3

Impacts of Aging and Relative Humidity on Wildfire Smoke in Indoor Environments. LIORA MAEL, Andrew Martin, Kathryn Mayer, Dustin Poppendieck, Delphine K. Farmer, Marina Vance, *University of Colorado Boulder*

Wildfires have been shown to have a significant impact on air quality in the United States and subsequently human health. An important, often overlooked, aspect of wildfire smoke studies is the potential transformations that smoke can undergo after it infiltrates into residential buildings and how this can influence the composition of the air indoors. During the Chemical Assessment of Surfaces and Air (CASA) study, fresh and aged smoke were injected into the NIST Net-Zero Energy Residential Test Facility, where the resulting differences in physical properties of the smoke, specifically sub- and supermicron particle diameter and number distributions were monitored using multiple Scanning Mobility Particle Sizers (SMPS) and an Aerodynamic Particle Sizer (APS). Ponderosa pine smoke was generated with a cocktail smoker to simulate wildfire smoke, and either directly injected into the house or aged in a flexible Teflon chamber with approximately 20 ppm (40 mg/m^3) of ozone for an hour prior to injection. To simulate circumstances when other sources of indoor air pollution are present, ozone was injected into the house following smoke additions, reaching concentrations of approximately 50 ppb (100 µg/m^3). When fresh smoke was directly injected into the house, no new particle formation (NPF) was observed following the ozone addition, however, NPF was observed with the addition of aged smoke and ozone, forming particles that remained <100 nm in diameter. Additionally, effects of high and low indoor relative humidity on particle size distributions were observed. These results will help us determine appropriate mitigation strategies and understand the health risks and impacts of wildfire smoke infiltration into houses.

1BC.4

Deposited Biomass Burning Aerosol as a Possible Source of Reactive Species to Air-Exposed Surface Films. DOUGLAS COLLINS, April Hurlock, Naomi Douek, *Bucknell University*

Multiphase chemical reactions can lead to the production/emission of trace gases and alterations to the chemical composition of the condensed phase. In consideration of the long-term aging of air-exposed surface films, one must consider the range of possible reactive species, and studies have focused heavily on gaseous oxidants. Aerosol particles from combustion sources have the potential to harbor reactive oxygen species, as evidenced by measurements of their oxidative potential. Recognizing the chemical role of reactive oxygen species from aerosol particles when deposited in or on biological subjects, we sought to establish the potential for deposited aerosol particles to deliver oxidants to environmental surfaces, such as those inside buildings. Using a non-volatile antioxidant, tris(carboxyethyl) phosphine (TCEP), to make a thin film on a horizontal surface, it was found that the deposition of side-stream tobacco smoke particles caused oxidation reactions to occur in a small laboratory chamber. Similar experiments were conducted in which the TCEP film was replaced with other organic chemicals, each having different functional groups, including oleic acid, bis(ethylhexyl) sebacate, bisphenol A, and squalene. From these initial tobacco smoke studies, investigations were extended to the oxidation of organic surface films upon the deposition of biomass burning particles. Our studies suggest that the delivery of reactive oxygen species to surfaces by deposited particles should be considered in environments that are impacted by significant particulate matter pollution. These studies set the stage for a more comprehensive consideration of the chemical aging of environmental surface films both indoors and outdoors.

1BC.5

Impact of Do-It-Yourself and Commercial Air Cleaner Use on Residential PM2.5 in a Smoke-Impacted Community.

PRADEEP PRATHIBHA, Mallory Turner, Madison Kirshner, Amber Batchelder, Brian McCaughey, Julia Carlstad, Ann Chelminski, Ana Rappold, Beth Hassett-Sipple, Amara Holder, *U.S. Environmental Protection Agency*

Low-cost, Do-It-Yourself air cleaners (“DACs,” MERV13 electrostatic filter attached to a box fan) are an affordable alternative to commercial air cleaners (“CACs”) to reduce residential exposure to particulate matter in wildfire-impacted areas. However, air quality improvements may vary with user behavior. In this pilot study, we evaluated the impact of air cleaner use on $PM_{2.5}$ and change in air cleaner usage due to an air quality display (“AQD”) in a smoke-impacted community in Hoopa, CA.

We measured indoor and outdoor $PM_{2.5}$ to characterize (1) infiltration ratio (“IR”) during the wildfire season (“FS,” n=6 homes) and (2) all indoor $PM_{2.5}$ during winter (“WS,” n=11 homes), when woodstove use is prevalent. We monitored baseline air quality, then sequentially provided a DAC, a CAC and, finally, an AQD with which participants used their preferred air cleaner. Then, mixed linear models were used to quantify associations [95% CI] of air cleaner use (logged with power meters) with IR (FS only) and 10-min mean indoor $PM_{2.5}$.

During FS, relative to the baseline, IR was 21.4% [7.1-33.5] and 7.6% [0.3-14.4] lower when DAC and CAC were running, respectively. Infiltrated $PM_{2.5}$ was 21.5% [16.5-26.3] and 19.9% [15.2-24.4] lower in DAC and CAC phases, respectively. Similarly, during WS, DAC and CAC use were associated with 10.0% [8.5-11.6] and 14.9% [13.2-16.7] reduction in indoor $PM_{2.5}$, respectively. Finally, air cleaner use was 28-33% lower during AQD phase.

While both cleaners reduced indoor $PM_{2.5}$, participant adherence to usage instructions in DAC and CAC phases (≥8 hours while home) varied. The CAC was sometimes run continuously, but the DAC was operated less than instructed, with noise being the most common complaint. Organizations in smoke-impacted communities should account for this behavioral aspect when developing approaches to mitigate exposure to indoor $PM_{2.5}$.

Disclaimer: Does not reflect EPA views/policy.

1BC.6

Measurements of VOCs in Homes Impacted by Smoke from the Marshall Fire.

WILLIAM DRESSER, Alexander Bradley, Abby Koss, Joost de Gouw, *CU Boulder*

The Marshall Fire was one of the most destructive fires in Colorado history, and burned and damaged over 1000 structures in Boulder County. In the immediate aftermath of the fire, there was an intense interest in understanding the persistent air quality effects of the fire both due to its close proximity to unburned homes as well as the unique nature of the fire, in which mostly man-made materials burned as opposed to biomass. While smoke emissions from traditional wildfires have been well studied and characterized, the emissions from building materials are less well understood and can vary significantly based on the composition. We are interested in how the smoke from this fire infiltrated and then interacted in indoor environments, which have large surface reservoirs, leading to noticeable, persistent indoor air quality effects. In the weeks following the fire, multiple instruments were deployed in a smoke-impacted home immediately adjacent to one of the burn areas to monitor effects. Our measurements quantified gas-phase Volatile Organic Compounds (VOCs) and were carried out with a Vocus Proton-Transfer-Reaction Time-of-Flight Mass Spectrometer (Vocus PTR-TOFMS) and an Aerodyne Gas Chromatograph (GC). Both indoor and outdoor levels were measured to quantify indoor enhancements and the long-term trends therein. Ventilation experiments as well as mitigation tests using Corsi-Rosenthal boxes were done and analyzed with respect to changes in indoor VOC concentration. These experiments can also give insight into indoor reservoirs of VOCs and compared to findings in non-smoke impacted indoor environments. Break-down products expected from pyrolysis of compounds in homes, such as brominated flame retardants, were investigated. Quantification was done to inform VOC exposure after the fire compared to known health and safety values.

1BC.7

Using Low-Cost Sensor Networks To Estimate Health Impacts of Indoor Exposures to Wildfire Emissions. ELLIOTT GALL, Ruth Dittrich, Julia Weinand, Franklyn Santos, Joshua Zulueta, *Portland State University*

Wildfires are increasing in frequency and intensity and are a substantial source of ambient $PM_{2.5}$. Because populations are advised to stay indoors when outdoor air quality is degraded by a wildfire, indoor environments can be a major determinant of exposure to products of biomass combustion. In this study, we collect measurements of indoor and outdoor $PM_{2.5}$ levels from an adventitiously deployed low-cost sensor network (PurpleAir) in the Portland, OR, USA metropolitan area during the Labor Day fires of September 2020. We develop a time and location specific $PM_{2.5}$ correction factor using linear regression between outdoor PurpleAir monitors and identified, nearby reference monitors operated by the Oregon Department of Environmental Quality. We identified 14 PurpleAir sensors in the metropolitan region identified as deployed indoors during the period of elevated outdoor $PM_{2.5}$ due to wildfires; we estimate $PM_{2.5}$ concentrations in these indoor spaces by applying the correction determined from outdoor sensors and reference stations. Infiltration factors are estimated by partitioning the time-series indoor and outdoor $PM_{2.5}$ data for analysis during periods when indoor sources are expected to be minimal. Infiltration factors of $PM_{2.5}$ and measured $PM_{2.5}$ concentrations will be used as inputs into a model (BenMAP-CE) to estimate the health costs of wildfire PM exposure, including exploration of the impact of building infiltration factor on health outcomes due to exposure to wildfire associated $PM_{2.5}$.

1HA.1

Climate-induced Air Quality Deterioration and Associated Health Risks. PENGFEI LIU, Qiao Zhu, Haisu Zhang, Haomin Li, Bin Bai, Howard Chang, Loretta Mickley, Joel Schwartz, Liuhua Shi, *Georgia Institute of Technology*

Climate change is the greatest public health challenge of the 21st century. While previous studies have proposed numerous pathways of climate-related health impacts, the “climate penalty” effect via air quality remains poorly understood. Here, we examine the sensitivities of surface fine particulate matter (PM2.5) and ozone concentrations to summer mean temperature anomalies in the contiguous US, by leveraging high-resolution (1×1 km2) datasets derived from remote sensing and machine learning models. The results indicate higher PM2.5 and ozone levels in warmer summers compared to the cooler summers in most regions of the US. GEOS-Chem simulations indicate that the observed PM2.5-temperature sensitivity in the Southeast US is mostly attributable to the aqueous-phase formation of secondary organic aerosol, while the PM2.5-temperature sensitivity in the Western US is largely due to wildfires. Statistical analyses suggest that the mediation effect of air pollution can explain a significant fraction of the association between summer temperature and various cardiovascular and respiratory outcomes.

1HA.2

Spray-Dried Encapsulated Iron for Food Fortification.

ALBERTO BALDELLI, Yigong Guo, Anubhav Pratap-Singh, *The University of British Columbia*

Anemia can result from food deficiency. Food fortification is used for decreasing the number of people affected by anemia in developed countries. Microencapsulation helps protect any excipient, including minerals, from degradation and can be maintained in a stable environment. Spray drying is chosen by numerous groups of previous references. We aim to clarify the influence of spray-dried microparticles' formulation on the bioavailability of iron compounds. Solutions composed of maltodextrin (0.9 g/100 ml), iron gluconate (0.9 g/100 ml), and a mucoadhesive polymer (0.9 g/100 ml) were sprayed with a Mini Spray Dryer at an inlet and outlet temperatures of 90 and 55°C, respectively. The polymers were hydroxypropyl methylcellulose (HP-MC), methylcellulose (MC), Carrageenan, and Dextran. By changing the polymer forming the shell of the microparticles, the morphology and the projected area equivalent diameter da are almost unchanged. The polymers show similar physical properties, such as a molecular weight higher than the other components, ensuring the formation of a shell. The use of mucoadhesive polymers is validated by the increase in detachment force of 61 and 75 % by comparing the cases without and with HP-MC and in contact with a human intestine and a porcine stomach wall, respectively. The detachment force is higher when using the polymer HP-MC (an average of 1.5 N). The importance of encapsulation is shown in Figure 1 e; the viability of Caco 2 cells is less affected when in contact with encapsulated iron than the pure one. When applying 12 mg/ml of iron, the cell viability over the control is 65 for pure and 200 % for encapsulated ones. This effect could be due to the slowest release rate generated by the encapsulating shell. For the same reason, cell uptake is highly increased when using encapsulated iron for any polymer selected.

1HA.3

Measurement Artifacts in the Dithiothreitol (DTT) Oxidative Potential Assay Caused by Precipitation of Aqueous Transition Metals.

JAYASHREE YALAMANCHILI, Christopher Hennigan, Brian Reed, *University of Maryland, Baltimore County*

Transition metals in particulate matter (PM) are hypothesized to have enhanced toxicity based on their ability to catalyze reactive oxygen species (ROS) generation. Acellular assays are widely used to measure the oxidative potential (OP) of various species – including transition metals – in PM. Many OP assays, including the dithiothreitol (DTT) and ascorbic acid (AA) assays, use a phosphate buffer matrix to simulate human body conditions (pH 7.4 and 37 °C). In this work, we conducted experiments to characterize metal precipitation in the DTT assay using aqueous extracts of a well-studied PM standard (NIST SRM-1648a, urban particulate matter). Precipitation was detected using laser particle light scattering as well as microscopic analysis (SEM and TEM) of filtered solids coupled with chemical analysis of dissolved metals to quantify metal removal. Our combination of measurements confirmed rapid metal precipitation in the DTT assay. Metal phase transitions from the aqueous to solid form for Fe, Mn, Al, Ca, Pb, Mg, Zn, Cu, and V were detected and likely occur through a variety of mechanisms, including co-precipitation and adsorption. We observed an increase in particle formation with increased metal concentrations. The effect of the metal phase (solid vs. aqueous) on the OP measured by the DTT assay was characterized using the urban PM: there was a significant difference in the OP measured due to the metal phase. Finally, the effects of the phosphate buffer concentration on metal precipitation and the measured OP in the DTT assay were investigated. The buffer concentration was directly proportional to the measured OP for Fe and Mn, but inversely proportional to Cu, indicating that the DTT assay is likely sensitive to the type and amount of solids in solution. The implications of these results for other acellular OP assays and PM toxicity are discussed.

1HA.4

Incident Dementia and Long-Term Exposure to Constituents of U.S. Fine Particle Air Pollution: A National Cohort Study.

LIUHUA SHI, Qiao Zhu, Yifan Wang, Hua Hao, Haisu Zhang, Aaron van Donkelaar, Randall Martin, Heresh Amini, Kyle Steenland, Jeremy A. Sarnat, Howard Chang, Jeremiah Liu, Tszshan Ma, Haomin Li, William M. Caudle, Rodney J. Weber, Pengfei Liu, *Emory University*

Background: Growing evidence has suggested that PM2.5 likely increases the risks of neurological disorders, yet little is known about the relative contributions of different constituents. Understanding constituent-specific effects are critical to targeting emissions reductions of specific sources with the greatest health protection.

Method: We conducted a nationwide population-based cohort study (2000-2017), by leveraging the Medicare Chronic Conditions Warehouse database and two sets of high-resolution, multiple-species, air pollution datasets to investigate the impact of long-term exposure to PM2.5 constituents on incident dementia and Alzheimer's disease (AD). Incident dementia and AD were identified from Medicare claims (2000-2017), including inpatient and outpatient claims, carrier file (primarily doctor visits), skilled nursing facility, and home health-care claims. Hazard ratios for dementia and AD were estimated using single- and multi-constituent Cox proportional hazards models, and penalized splines were used to evaluate potential nonlinear concentration-response relationships. We further tested effect modifications by individual- and community-level characteristics.

Results: Of the 18.5 million dementia and 19.2 million AD cohorts, 31.5% and 14.6% developed dementia and AD events, respectively. From the single-pollutant models, an interquartile range (IQR) increase in PM2.5 mass was associated with an increase in dementia incidence ranging between 6.3 (95% CI: 5.8%-6.7%) to 6.6% (95% CI: 6.2%-7.1%) by using two exposure datasets. For different PM2.5 constituents, associations remained significant in black carbon (BC), organic matter (OM), sulfate (SO42−), and ammonium (NH4+) for both endpoints. Increases in exposure to SO42− and BC per IQR, and increase in exposure to BC per 1 µg/m3, had the strongest associations with incident dementia or AD. There was linearity in the concentration-response (C-R) relationship for BC, SO42−, and NH4+ with both endpoints. The C-R relationships for OM, DUST, and NO3− also show an essentially linear association with both endpoints until high, and less frequently occurring concentrations.

Conclusion: Our study suggests that long-term exposure to PM2.5 is significantly associated with increased incident dementia and AD, and that different constituents have different neurotoxicity. Reduction of PM2.5 emissions, especially for main sources of black carbon and sulfate, may reduce the burden of dementia or AD in the aging United States population.

1HA.5

Measurement of Aerosol Emissions and Exposure to Firefighters during Fire Training.

SHRUTI CHOUDHARY, Darlington Imhanzuaria, Erin Kobetz, Alberto Caban-Martinez, Pratim Biswas, *University of Miami*

Firefighters (FF) are often exposed to toxic aerosols and gaseous species during fire response activities. Occupational industrial hygiene and biomonitoring studies have documented fire effluent from fire events to be hazardous. Epidemiologic studies reported by NIOSH have documented increased rates of specific cancers among FF[1]. Even though FF use personnel protective equipment (PPE) in the fire scene, movement, fate, and transport of carcinogenic products of combustion from fire are not well characterized, particularly in the fire training scenario. In this study, we measure aerosol emissions during the fire training using a network of low-cost particulate matter sensors and GRIMM aerosol spectrometer and collect gaseous samples for Gas Chromatography-Mass Chromatography analysis. Further, we evaluate (i) risk factors of ambient toxic aerosols and gaseous emissions during fire burns and classify them within hot, warm, cold zones and FF training and fire suppression activities, (ii) secondary emissions from FF PPE and gears associated due to particle resuspension during gear doffing procedure, (iii) respiratory system particle deposition using International Commission on Radiological Protection (ICRP) respiratory deposition model. We then suggest possible solutions to minimize toxic aerosols and gaseous species from emissions among firefighters when training fire suppression activities.

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1HA.6

Long-term Air Quality and Health Effects of Dairy Digesters in the Future San Joaquin Valley. Jia Jiang, Ali Akherati, Hamed El-Mashad, Frank Mitloehner, MICHAEL KLEEMAN, *University of California, Davis*

California, as the nation's leader in milk production, has more than 1.5M cows that emit large quantities of methane (a potent greenhouse gas). Reducing these methane emissions is a priority for dairy farms as California works towards an 80% greenhouse gas reduction by the year 2050. Widespread adoption of anaerobic digesters that capture methane from animal manure provides one option for reduced methane emissions. Carbon dioxide is a less potent greenhouse gas than methane, and so the power produced from burning digester gas has a net climate benefit. Many farms in the San Joaquin Valley (SJV) have already adopted some form of this digester technology, but a rigorous evaluation of the air quality impacts remains to be completed.

Here we use a regional chemical transport model to predict pollutant concentrations under multiple future scenarios to better understand and quantify the long-term air quality effects of widespread digester adoption in the SJV. A Business as Usual (BAU) scenario is contrasted with a complete digester adoption scenario and a perfect alternative manure management scenario that eliminates dairy VOC emissions without the use of digesters. All scenarios are evaluated across 32 randomly selected weeks over a 10-year period from the year 2046 to 2055 to establish a long-term average impact in the presence of ENSO variability. All scenarios are evaluated over a range of background atmospheres to explore the effects of changing chemical regimes. The impact of widespread dairy digester adoption O_3 and $PM_{2.5}$ concentrations in the future SJV atmosphere will be reported. The health co-benefits under each scenario will also be calculated using the Environmental Benefits Mapping and Analysis Program-Community Edition (BenMap-CE), with the goal of providing additional insight into race/ethnicity disparities in future air pollution exposure in different practices.

1HA.7

The Nervous Impact of Short Term Exposure to Cooking Ultrafine Particles. Motahareh Naseri, MEHDI AMOUEI TORKMAHALLEH, Seyedeh Mohadeseh Kazemitabar, Seyedeh Ayeh Esmaili Talesh, Sahar Sadeghi, Milad Malekipirbazari, Mojtaba Jouzizadeh, Reza Khanbabaie, Dhawal Shah, Flemming Cassee, Byron Crape, Giorgio Buonanno, Luca Stabile, *University of Illinois at Chicago*

Studies confirmed that cooking is a major source of indoor particles that could affect people's health. The particle sizes emitted from cooking are generally within the ultrafine particle (UFP) range. The impact of cooking particles on the human brain is poorly investigated. This study summarized a clinical study investigating the effect of cooking ultrafine particles on the human brain. Thirty healthy volunteers above 25 years old have participated on two consecutive days. The first day was a control experiment (without cooking), and the second day was an exposure experiment (with cooking). The experiments were conducted in an apartment equipped with a gas stove. Frying chicken and French fries were conducted for 20 minutes at 9:30 am on the second day (cooking day). Brain activity was measured using an Electroencephalograph (QEEG) in ten steps each day. As a background, the first measurement was at 9:00 am and continued after cooking, 30 minutes, 60 minutes, 90 minutes, 2 hours, 4 hours, 6 hours, 8 hours, and 10 hours after cooking. The last EEG measurement was conducted at 9:00 am on the third day of experiments (23 hours after cooking). Our preliminary results showed that the greatest changes in the brain were 60-90 minutes after cooking. Alpha, Beta, and theta band decreased 90 minutes after cooking, but the delta band increased.

1SA.1

Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT): A New Ground-based High Time-resolution Air Quality Monitoring Network. NGA LEE NG, Ann Dillner, Roya Bahreini, Armistead G. Russell, Jeff de La Beaujardiere, James Flynn, Drew Gentner, Robert Griffin, Lelia Hawkins, Jose-Luis Jimenez, Jingqiu Mao, Shane Murphy, Eric Nienhouse, Albert Presto, Sean Raffuse, Allen Robinson, John Seinfeld, Jason Surratt, Joel A. Thornton, Bridget Thrasher, *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 is funded through the NSF Mid-Scale Research Infrastructure program. A total of 12 sites will be established across the country, leveraging existing atmospheric networks including National Core (NCore), Photochemical Assessment Monitoring Stations (PAMS), Interagency Monitoring of Visual Environments (IMPROVE), National Ecological Observatory Network (NEON), South Coast Air Quality Management District (SCQAMD), and Houston Network of Environmental Towers (HNET). The ASCENT sites cover rural/remote/background, urban, and tribal sites. Each site will be equipped with a suite of advanced aerosol instrumentation for real-time measurements of fine aerosol chemical composition and properties: Aerosol Chemical Speciation Monitor (ACSM, non-refractory aerosols), Xact (trace metals), Aethalometer (black/brown carbon), and Scanning Mobility Particle Sizer (SMPS, aerosol number size distribution and concentration). In addition, value-added products will be developed, including parameterizations of FT-IR and ACSM data to increase the chemical resolution of organic aerosols from the ACSM, as well as aerosol source apportionment analyses. A comprehensive data infrastructure will also be developed for automated data quality assurance/control, upload/download, discovery/visualization, and long-term data preservation, providing open and free access to ASCENT database. ASCENT will enable a wide range of new and exciting research capabilities in atmospheric science, climate, and air quality, and will advance our understanding of aerosol sources and characteristics on spatiotemporal scales not previously possible. ASCENT will also provide critical information to fully utilize new observations from upcoming satellite-based instruments. With the development of the mid-scale infrastructure, ASCENT provides unique opportunities for research scientists and policy analysts to study chemical transformations of aerosols on short time scales due to changes in fuel, land use, and emissions.

1SA.2

Computation of Numerically Exact First- and Second-Order Sensitivities of Biogenic Aerosols Formation Using a Column Model Version of CMAQ-hyd. JIACHEN LIU, Eric Chen, Ryan Russell, Shannon Capps, *Drexel University*

Secondary organic aerosols (SOA) are generated by complex transformations of organic molecule emissions and are a significant contributing factor to atmospheric particulate matter (PM) concentrations. High PM concentrations can lead to regional haze and pose health risks to the public. The formation of SOAs from biogenic precursors including monoterpenes remains poorly understood, and biogenic SOAs have become a major source of total SOA concentrations, especially in the southeastern U.S. Therefore, understanding the sensitivities of biogenic precursors with respect to SOA formation is essential for guiding scientists and policymakers to understand the background biogenic SOA concentrations. Previous methods of calculating the sensitivity coefficients include the finite difference method (FDM), the direct decoupled method (DDM), and the adjoint method. The finite difference method suffers from truncation and cancellation errors, while the DDM and the adjoint method are relatively hard to implement and update in chemical transport models. Here, we propose an alternate approach to calculate first- and second-order sensitivities. This method is an operator overloading approach that can calculate the exact sensitivity coefficients through one single run of the model. We applied this method in the Community Multiscale Air Quality (CMAQ) model v.5.3 with the cb6r3-aero7 mechanism to formulate the CMAQ-hyd model. In this work, we apply a column model version of the CMAQ-hyd to compute the exact sensitivities of SOA concentrations with respect to their precursor concentrations. This type of sensitivity analysis could guide policymakers in evaluating the current Regional Haze Rule and potentially revisions of the National Ambient Air Quality Standard for the total atmospheric $PM_{2.5}$ concentration in the future.

1SA.3

Polycyclic Aromatic Hydrocarbons in Background Air – A Single-particle Study on Their Sources and Atmospheric Processing in Northern Europe.

JOHANNES PASSIG, Julian Schade, Robert Irsig, Thomas Kröger-Badge, Hendryk Czech, Henrik Fallgren, Jana Moldanova, Martin Sklorz, Thorsten Streibel, Andreas Walte, Ralf Zimmermann, *Helmholtz Zentrum München and University of Rostock*

Inhalation of Polycyclic Aromatic Hydrocarbons (PAHs) is a well-known cause of morbidity and mortality (Holme et al., 2019). Furthermore, PAHs have important climate effects, e.g. via direct absorption, photooxidation and cloud condensation. However, distribution pathways and atmospheric interactions of PAHs are not fully understood (Keyte et al. 2013). We recently introduced ionization methods for single-partice mass spectrometry (SPMS) that combine different ionization pathways and produce mass spectra from traces of PAHs – in addition to the particle's inorganic composition (Schade et al. 2019). This approach is combined with resonant ionzation of iron, a further health-relevant aerosol compound with strong effects on marine ecosystems (Passig et al., 2020).

Here we present results from the first ambient air study on the single-particle resolved distribution and sources of PAHs (Passig et al. 2022). At at the Swedish west coast, we detected long-range transported particles from traffic emissions, residential heating, biomass burning and even individual ship plumes. The combined single-particle information from PAHs and inorganics allows novel source apportionment and provides unprecedented insight into complex aerosols. We show, how PAHs might be harnessed as a molecular sensor for atmospheric processing. Therefore, we demonstrate that different ageing effects e.g. PAH degradation, oligomerization and secondary aerosol formation can be unravelled from the combined data of PAHs, inorganic source markers and secondary material. Finally, our study gives an estimate on the number fraction and origin of PAH-containig particles in the accumulation and coarse mode during autumn in northern Europe.

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1SA.4

Understanding the Sources and Light Absorption Properties of Brown Carbon Aerosols via Source Apportionment Analysis of Combined AMS and UV-vis Measurements.

WENQING JIANG, Christopher Niedek, Lan Ma, Cort Anastasio, Qi Zhang, *University of California, Davis*

Atmospheric brown carbon (BrC) which absorbs sunlight efficiently in the near-UV and visible ranges can significantly impact the radiative balance of the earth. However, the chemical and light absorption properties of BrC from different sources remain poorly understood. To address this knowledge gap, in this study, $PM_{2.5}$ samples collected at Davis, CA from Nov 2019 to Oct 2020 were analyzed using high-resolution time-of-flight aerosol mass spectrometry (HR-AMS), ion chromatography (IC), total organic carbon (TOC) analyzer, and ultraviolet–visible spectroscopy (UV-vis). Positive matrix factorization (PMF) was applied to the combined HR-AMS mass spectra and UV-vis spectra. Five organic aerosol (OA) factors with distinctive mass spectra and UV-vis spectra profiles were identified, including a fresh biomass burning OA (BBOA) factor with enhanced m/z 60 and 73 signals, an oxygenated OA (OOA) tightly correlating with secondary inorganic aerosol species, and a wintertime OOA influenced by aqueous reactions. All the OA factors are moderately oxidized with O/C ratios in the range of 0.46 – 0.60, but their light absorption properties are considerably different. Among the five OA factors, the fresh BBOA is the most light-absorbing, with a mass absorption efficiency (MAE) of 1.6 $m^2 g^{-1}$ at 365 nm, consistent with previously reported MAE values for BB-influenced aerosols from residential combustion. This result suggests biomass burning is a significant source of light-absorbing aerosols at Davis. The MAE values of the 4 different OOAs are in the range of 0.3 – 0.8 $m^2 g^{-1}$ at 365 nm and their $AAE_{300-400nm}$ values are in the range of 7.2 – 8.3, higher than that of BBOA ($AAE_{300-400nm}$ = 5.9). The aqueous-phase OOA resolved from the winter months appears to be more absorbing than the summertime OOAs. These results may help interpret the climate forcing of ambient aerosols as well as the photosensitized production of oxidants in condensed phases.

1SA.5

Metallic Trace Elements Shipping Profile by PM1 Source Apportionment in a Mediterranean Port City. LISE LE BERRE, Benjamin Chazeau, Brice Temime-Roussel, Grazia Maria Lanzafame, Alexandre Armengaud, Stéphane Sauvage, Leonidas Ntziachristos, Nicolas Marchand, Barbara D'Anna, Henri Wortham, *Aix Marseille Univ, CNRS, LCE, Marseille, France*

Shipping emissions in ports can have substantial impacts on air quality and population health in the nearby urban environment. Legislative efforts made in recent years have reduced emissions of some gaseous pollutants but the aerosol chemical composition, in particular metals composition in submicronic fraction, is little documented.

More than 30 trace metals have been monitored with two online metals analysers (Xact 625i) in addition to regulated pollutants ($PM_{2.5}$, PM_{10}, NOX, O_3 and SO_2) and ultrafine particle number during two intensive campaigns in Marseille (France) in the summer 2021. Samples were taken simultaneously along the port berths and on the urban background aerosol site MRS-LCP located 2 km from the port. As the second largest city of France, Marseille represents a challenging environment for source apportionment (SA), as it combines multiple anthropogenic sources including intensive traffic and various industrial activities in addition to shipping.

This work presents the SA analysis performed on trace elements using Positive Matrix Factorization (PMF) resolved with the multilinear engine approach (SoFi Pro) on both sampling sites.

Inside the port area, the half hourly metals measurements allowed to define a “shipping” profile by SA analysis. This profile is dominated by Vanadium (V) and Nickel (Ni) and is associated with ultrafine particles (D_{mob}<70 nm). On a daily scale, the profile correlates with ship arrivals and departures.

On the background urban site, PMF results from the summer 2019 showed that a shipping factor enriched in V and Ni could be retrieved. The use of the shipping profile determined inside the port area to constrain PMF run allowed to better assess the contribution of this source on air quality. In addition, sources profile comparison between summer 2019 and 2021 highlights the evolution of shipping emissions following the 0.5% fuels sulfur limit implemented in 2020.

1SA.6

Evaluating the Trends in Sources of Ambient Particle-Bound Metals in the Environmental Justice Community of Paramount, CA, during Pre- and Post-COVID-19 Lockdown Periods. MOHAMMAD SOWLAT, Sina Hasheminassab, Bill Grant, Payam Pakbin, Jason Low, Andrea Polidori, *South Coast Air Quality Management District*

In this study, we evaluated the long-term trends in composition and sources of particulate metals in the environmental justice (EJ) community of Paramount, California. In this community, several known sources of particulate metals are in close proximity to sensitive receptors, increasing the level of exposure to these pollutants, many of which are known toxic air contaminants (TACs). The literature suggests that there are disproportionate changes in air quality due to COVID-19 lockdowns in EJ and non-EJ communities; therefore, in this work we paid particular attention to the trends pre- and post-COVID-19 lockdown. We used a Xact 625 ambient metal monitor to measure the concentrations of metals in total suspended particulates (TSP) between May 2017 and December 2020. We used the USEPA’s Positive Matrix Factorization (PMF) model to apportion the sources of ambient particulate metals. The PMF analysis identified 5 factors that were associated with 3 major sources: traffic, industry, and soil dust. Traffic and soil dust contributions exhibited significant reductions after the stay-at-home order; this is believed to have been caused by decreased human activities. However, as the lockdown measures were lifted, the contributions of these sources gradually reverted to pre-lockdown levels. On the other hand, contributions of industrial factors dropped significantly during the stay-at-home order (due to the combined effect of reduced demand, production, and revenues during the pandemic) and remained low throughout the rest of 2020. We note that the contribution of industrial-related sources declined even before the COVID-19 lockdown, likely due to the impact of imposed tariffs and reduced demand for steel and aluminum parts, and partly to the regulatory actions by the South Coast Air Quality Management District in this community. Altogether, these actions and events have led to substantial reductions in the levels of particulate metals emitted from industrial sources in the EJ community of Paramount, with reductions as high as 80% depending on the specific metal and the pertinent source.

1SA.7

Development of a Database for Factor Analysis-Derived Profiles from TAG Measurements. MICHAEL WALKER, Claire Fortenberry, Brent Williams, *Washington University in St. Louis*

Over the last 15 years, different types of thermal desorption aerosol gas chromatograph (TAG) instruments have been utilized in laboratory and field measurements to provide insight to the composition of organic gases and particles in the atmosphere by coupling in-situ collection and thermal desorption techniques with gas chromatography – mass spectrometry (GC-MS). However, the amount of data generated by these instruments and time required for processing remain significant barriers, as thousands of compounds may be identified in the tens of thousands of spectra that can be acquired hourly.

As an alternative, or complement, to peak integration methods, positive matrix factorization and related factor analysis methods can be leveraged to make the data more manageable. Depending upon the specific processing approach, the generated factor profiles can help identify chemically distinct classes of organic compounds based upon their similar mass spectral fragmentation patterns, or can help to identify compounds that covary across chromatograms, indicative of a common source. In order to further leverage the wealth of information contained within these factor profiles, a custom database has been developed to serve as a repository for existing and future datasets.

To highlight the benefits of this database, and the various methods for quantitatively comparing the profiles, factors from both indoor and outdoor measurements during the Air Composition and Reactivity from Outdoor aNd Indoor Mixing (ACRONIM) campaigns were utilized to identify related factors from a variety of laboratory and field measurements. Despite differences in operating conditions, instrumentation and measurement locations, appropriate processing of the data allows for direct comparisons of the volatility-resolved chemical information, providing the framework required for future, real-time source apportionment with TAG measurements. Furthermore, the framework of this database could readily be extended to any measurement technique that involves a separation step prior to detection with a mass spectrometer.

1UA.1

Seasonal Variation in Ambient Air Pollutants and Influence of Meteorological Factors in an Urban Environment, Sri Lanka. BUDDHI PUSHPAWELA, Sherly Shelton, Gayathri Liyanage, Sanduni Jayasekara, Akila Jayasundara, LestyDias Jayasuriya, *California Institute of Technology*

The deterioration of air quality indoors and outdoors is a significant public health problem in Sri Lanka. Few studies have investigated the effects of ambient air pollutants on human health. To the best of the author's knowledge, the seasonal variability of ambient air pollutants has not been previously reported.

The study aimed to provide a broader perspective on the seasonal variation of CO, NO_2, SO_2, O_3, $PM_{2.5,}$ and PM_{10} and possible relationship between air pollution and meteorological factors in two cities in Sri Lanka. The data were obtained from ambient air quality monitoring stations at Colombo and Kandy from 2018 to 2021, excluding the COVID-19 lockdown. The analysis was based on four seasons; Southwest monsoon (SWM; June-September), Northeast monsoon (NEM; December-February), first inter-monsoon (FIM; March-May), and second inter-monsoon (SIM; October-November) period. The results showed that the diurnal variation of measured pollutants except for O_3 for all seasons followed a similar bimodal distribution pattern in both cities. We observed the hourly average concentrations of pollutants reach their maximum during the morning (6-8 am) and the evening (6-8 pm) hours, irrespective of the seasons. This observed morning and evening peaks coincided well with the morning and evening rush hour traffic.

The results showed a considerable seasonal variation in the concentration of all pollutants. The minimum and maximum daytime pollutant concentrations in Colombo are recorded in the SWM and NEM seasons. In Kandy, the maximum daytime concentration of O_3, NO_2, $PM_{2.5}$, and PM_{10} are recorded for the FIM season, while CO and SO_2, are recorded at maximum concentration during the SWM season. We found that wind speed and direction is the most influencing factor for pollutant concentration for all seasons. The findings help understand seasonal variation in ambient air quality, which contributes to formulating season-specific control measures to improve regional air quality.

1UA.2

Characterising the Seasonal Sources of Urban Organic Aerosol Using the Non-Targeted High-Resolution Mass Spectrometry and Factor Analysis. Sri Hapsari Budisulistiorini, DANIEL J. BRYANT, Jonathan Taylor, Alfred Mayhew, David Topping, Jacqueline Hamilton, *University of York*

Organic aerosol (OA) comprises a significant proportion of urban PM2.5. Using positive matrix factorisation (PMF) of bulk measurements of organic aerosol composition by aerosol mass spectrometry, the oxidised organic aerosol (OOA) is classified based on its volatility and oxidation state. This classification is useful but does not directly reveal the sources of OOA. Recently, molecular characterisation studies using high-resolution mass spectrometry (HRMS) techniques provided a deeper insight into the organic aerosol composition. The benefit of abundant organic molecules identified by the HRMS techniques comes with a drawback of difficulties in identifying their sources in the atmosphere.

This study aims to develop a new analytical approach to characterise the seasonal sources of OA. We applied PMF on HRMS data to classify organic aerosol sources in Beijing, China. PM2.5 samples were collected in Beijing, China, in winter 2016 and summer 2017. The organic species were identified using ultra-performance liquid chromatography coupled to a Q-Exactive Ultra-High Mass Range Hybrid Quadrupole-Orbitrap Mass Spectrometer with electrospray ionisation (UHPLC-ESI-Orbitrap MS). Datasets containing organic molecules identified over the observation periods were then analysed using the PMF, widely used to characterise the sources of aerosol measured by the online aerosol mass spectrometer.

The PMF analysis conducted in robust mode resulted in five and seven-factor solutions for winter and summer. The summer factor solution analysis revealed two biogenic secondary organic aerosol (SOA), two anthropogenic SOA, and three biomass burning OA sources. The contributions are ca. 22%, 15%, and 63% for biogenic, anthropogenic, and biomass burning sources, respectively. The large contribution of biomass burning is due to the long-range transport of biomass burning plumes from the western region.

This study demonstrates the capability of combining the non-targeted HRMS technique with factor analysis to characterise the sources of organic aerosol. Future studies will develop deep learning methods for source apportionment.

1UA.3

Regional Air Quality Implications of Volatile Chemical Emissions in Some North American Cities. Amirashkan Askari, ARTHUR W. H. CHAN, *University of Toronto*

Volatile chemical products (VCPs) have attracted attention as an emerging class of emission sources for Volatile Organic Compounds (VOCs). Given that most VCP studies have been focused on the United States, researching the air quality impacts of VCPs in other jurisdictions is of particular importance. In this work, we utilized a bottom-up approach to infer the annual VOC emissions from VCP sources in a typical year in the 2010s in Canada. It was estimated that VCPs accounted for more than 310 kilotonnes of VOC emissions in Canada, which is in good agreement with emission reports published by Environment and Climate Change Canada (ECCC). We speciated the VCP emission inventory of interest using CARB chemical profiles, which paved the way for further investigations about air pollution implications associated with the VCPs. We utilized spatial surrogates from regional demographics and employment statistics to downscale national VCP emissions to six major Canadian urban areas, including Toronto, Montreal, Vancouver, Calgary, Ottawa, and Edmonton. OH reactivities and SOA formation potentials due to VCP emissions were estimated for each region mentioned above. Indoor emissions of cleaners and coatings mainly drove the VCP OH reactivities spanning from slightly below one s^{-1} for Calgary to more than three s^{-1} for Vancouver. SOA potentials were estimated to be mainly driven by outdoor emission of the same sources and ranged from about 4 $\mu g/m^3$/[local CO ppm] for Calgary to about 13 $\mu g/m^3$/[local CO ppm] for Ottawa. Moreover, experimental strategies to verify these implications during future studies were discussed.

1UA.4

Volatile Chemical Product Contributions to the Urban Secondary Organic Aerosol Burden in the United States.

SREEJITH SASIDHARAN, Charles He, Qi Li, David Cocker, Karl Seltzer, Brian McDonald, Havala Pye, Jeffrey R. Pierce, Shantanu Jathar, *Colorado State University*

Volatile chemical products (VCPs) are an important source of oxygenated volatile organic compound (OVOC) emissions into the urban atmosphere. Although the OVOCs released from VCPs are understood to oxidize in the atmosphere, the chemical pathways that eventually lead to SOA formation in urban environments remain uncertain. In this work, we leveraged high NO_X environmental chamber data gathered at the University of California Riverside to develop parameters to represent SOA formation from a suite of VCP OVOCs. These VCP OVOCs included glycols, glycol ethers, oxygenated aromatics, and acetates. The SOA parameters were developed using SOM-TOMAS, a kinetic model that simulates the oxidation chemistry, thermodynamic properties, and microphysics of SOA. The SOM-TOMAS parameters were able to reproduce time-dependent SOA mass concentrations and the oxygen-to-carbon (O:C) ratios measured in the chamber experiments quite well. These parameters for OVOCs along with historical parameters for SOA precursors were used to develop a box model to study urban SOA formation in select megacities as well as nationwide. Consistent with recent work, the box modeling results found that VCPs account for more than half of all urban SOA formed from anthropogenic sources in Los Angeles, CA and New York City, NY. Of the SOA attributed to VCP use, more than three quarters of it arose from oxidation of VCP hydrocarbons and less than a quarter coming from VCP OVOCs. Ongoing work is focused on (i) identifying the most influential VCP OVOCs for SOA formation to aid design of laboratory and field experiments and (ii) understanding source contributions to anthropogenic SOA in cities across the United States.

1UA.5

Comparison of Organic Aerosol Composition and Source Distributions across Different Urban Microenvironments.

SUNHYE KIM, Abhishek Anand, Pavithra Ethi Rajan, Albert A. Presto, *Carnegie Mellon University*

Exposure to ambient fine particulate matter ($PM_{2.5}$) has hazardous health impacts worldwide. A major challenge in reducing $PM_{2.5}$ concentrations is that it comes from a variety of sources. This is especially true in urban areas, where there is a mixture of primary and secondary sources. In addition, there are large spatial variations in $PM_{2.5}$ concentration and composition in urban areas, and this variability is driven by differences in the spatial distribution of sources.

In summer 2021, field samples were collected at different urban sites at specified intervals (morning, midday, afternoon, and evening) using a mobile lab. NR-PM_1 was measured in real-time using an Aerosol Mass Spectrometer (AMS) along with Condensation Particle Counter (CPC), Aethalometer, and Gas monitors. Our results showed that organics generally increase with the traffic loads near sampling sites, especially during morning rush hour. The preliminary AMS-PMF (Positive Matrix Factorization) in our study demonstrated that the proportion of resolved factors can vary with land use. For instance, Cooking Organic Aerosols (COAs) were reliably identified (~20% of the total OA) in urban sampling locations near restaurants, while samples collected near asphalt paving had negligible COAs contributions. We also collected $PM_{2.5}$ samples on filters during the field campaign for the offline measurement using the iodide-based Chemical Ionization Mass Spectrometer (CIMS) with FIGAERO (Filter Inlet for Gases and AEROsols). This will provide additional molecular information (e.g. oxidation, chemical formula etc.) of OA in urban atmospheres.

This study aims to quantify the spatiotemporal variations of source-resolved organic emissions spanning a wide volatility range and analyze these trends in urban areas. To do so, we will examine the intra-city source contribution from multiple sectors including both traditional (e.g. traffic) and non-traditional (e.g. volatile chemical products [VCPs], paving, cooking) sources, and suggest possible marker ions of potential sites emitting VCPs.

1UA.6

Long-Term Trends of Ambient PM: Concurrent Effects of Emissions and Dispersion. YUNLE CHEN, David Q. Rich, Philip K. Hopke, *University of Rochester*

In the past several decades, a variety of efforts have been made in the United States to improve air quality, and ambient particulate matter (PM) concentrations have been used as a metric to evaluate the efficacy of environmental policies. However, ambient PM concentrations result from a combination of source emission/formation rates and meteorological conditions, which also change over time. Dispersion normalization was recently developed to account for the influence of meteorological dispersion on measured ambient PM concentrations.

In this presentation, we will present how dispersion normalization brings new insights into our understanding of long-term particulate size distribution, concentration, and composition variations in the northeastern US. We showed that for the past two decades, meteorological dispersion and emission/formation rate changes could work in the same or opposite directions to change the ambient PM, which veiled the efficacy of implemented air pollution mitigation measures in reducing air pollutants. In addition, source apportionment approaches like positive matric factorization (PMF) highly rely on temporal variations to separate factors. The variation caused by meteorological conditions could influence the accurate resolution of PM factors. Meteorological dispersion is an essential factor in determining ambient pollutant concentrations, and it is necessary to incorporate it in future studies.

1UA.7

U.S. EPA Progress on Developing Performance Testing Protocols and Targets for Particulate Matter Air Sensors. RACHELLE DUVALL, Andrea Clements, Karoline Barkjohn, Samuel Frederick, *US EPA*

Air sensors measuring particulate matter (PM) continue to undergo rapid expansion and use. However, data quality is highly variable which can reduce confidence in the accuracy of the data. Understanding how PM sensors perform and how sensor technologies compare to each other remains a challenge. To support users and manufacturers of air sensor technologies, the U.S. Environmental Protection Agency (U.S. EPA) released a report in 2021 outlining recommended testing protocols, metrics, and target values to evaluate the performance of fine PM ($PM_{2.5}$) air sensors for non-regulatory supplemental and informational monitoring applications. As a complement to the $PM_{2.5}$ report, the U.S. EPA is developing similar guidance for sensors measuring PM with diameters of 10 micrometers or less (PM_{10}). The goal of this work is to provide a consistent approach for evaluating sensor performance and reporting results to provide users with more confidence in the data and help them select sensors that meet their application needs. Additionally, this work is intended to encourage technology improvements and further development in the marketplace. This presentation will summarize the U.S. EPA's progress on building guidance for evaluating the performance of $PM_{2.5}$ and PM_{10} air sensors in field and laboratory settings.

Disclaimer: Although this abstract was reviewed by EPA and approved for presentation, it may not necessarily reflect official Agency policy.

2AC.1

Automated Mechanism Reduction Algorithm Applied to Isoprene Chemistry. FORWOOD WISER, V. Faye McNeill, Daniel Westervelt, Arlene Fiore, Daven Henze, Siddhartha Sen, *Columbia University*

Automated chemical mechanism reduction has been applied to complex combustion mechanisms in order to reduce the computational effort needed to run them. The isorpene atmospheric chemical mechanism is highly complex and is a good candidate for automated reduction due to the extensive use of reduced isoprene mechanisms, but no automated reduced mechanisms have been tested so far. In this work, the Caltech isoprene mechanism was reduced using an automated reguction algorithm. After additional manual adjustments, the resulting mechanism outperformned the published RACM isoprene mechanism while containing only 9 isoprene species and 17 reactions. This method shows significant promise in the development of mechanism reduction algorithms for atmospheric chemistry.

2AC.2

Measuring Photodegradation of Humic Substances with a Quartz Crystal Microbalance. MINGRUI SUN, Geoffrey Smith, *University of Georgia*

Formed from the oxidation of volatile organic compounds (VOCs) in the atmosphere, secondary organic aerosol (SOA) represents a large portion of global submicron-sized atmospheric organic aerosol. SOA is related to multiple processes that impact climate change. Photodegradation of SOA under solar radiation induces SOA evolution.[1] A better understanding of the extent and rate of SOA material photodegradation would lead to a better representation of SOA's roles in climate models. In this project, standard terrestrial and aquatic Humic substances were used as surrogates for atmospheric HUmic-Like Substance (HULIS). Mass loss kinetics of the humic substances' photodegradation under 305nm (26mW LED) and 405nm (100mW Laser) light were investigated using a quartz crystal microbalance (QCM). Humic substances were deposited on the quartz crystal through evaporation of its aqueous solution. Notable mass loss (>1% per day) was achieved with both wavelengths. Changes in the chemical properties of the humic substances upon exposure to UV light were investigated using Ultraviolet-Visible (Uv-Vis) Spectroscopy and Fourier Transform Infrared (FT-IR) Spectroscopy.

Reference:

Shrivastava, M., et al. (2017), Recent advances in understanding secondary organic aerosol: Implications for global climate forcing, Rev. Geophys., 55, 509– 559, doi:10.1002/2016RG000540.

2AC.3

Identifying a Missing Link: Confirmation of the Structure and Origin of 4-hydroperoxy-3-methylbut-2-enal (4-HPALD) with an Authentic Standard. REBECCA RICE, Jin Yan, Sebastian Gerber, Stephan Graf, Michael Kamrath, Felipe Lopez-Hilfiker, Matthieu Riva, Zhenfa Zhang, Jason Surratt, Avram Gold, *University of North Carolina at Chapel Hill*

Isoprene (C_5H_8) is the largest non-methane volatile organic compound emitted into the atmosphere. Isoprene reacts rapidly with ambient hydroxyl radicals (OH) and subsequent addition of O_2 results in the formation alkyl peroxy (RO_2) radicals. The fate of the initially formed RO_2 radicals has been the focus of continuing theoretical and experimental research. Under pristine conditions where bimolecular reactions of RO_2 are limited, the thermodynamically favored RO_2 undergoes an intramolecular H-shift followed by reaction with O_2 and elimination of HO_2 to yield 4-hydroperoxy aldehyde (4-HPALD, $C_5H_8O_3$), predicted to account for up to 13% of first-generation isoprene photochemical oxidation products. Mass spectrometric evidence has been reported for 4-HPALD, but lack of an authentic standard has precluded definitive confirmation of both the structure of 4-HPALD and its origin as a first-generation product of OH oxidation of isoprene.

We report the synthesis and characterization of 4-HPALD and establish that it is a major product of isoprene oxidation. Synthetic 4-HPALD is isolated as the peroxyhemiacetal. As expected for the 4-hydroperoxy aldehyde, ^1H NMR spectra show no evidence for equilibration with the carbonyl form, even in protic solvents, and gas-phase chemical analysis by CIMS also shows only a single form. OH oxidation of isoprene in an oxidation flow reactor coupled to an ion mobility source with an HR-CIMS detector unequivocally demonstrates 4-HPALD (and likely also 1-HPALD) as isoprene oxidation products. Although HPALDs have been discounted as significant contributors to SOA, oxidation of 4-HPALD in a potential aerosol mass (PAM) reactor in the presence of ozone and OH indicates 4-HPALD rapidly undergoes autooxidation reactions forming low-volatility particulate products. We have confirmed highly oxygenated compounds with compositions $C_5H_8O_6$ and $C_5H_{10}O_6$ likely from OH oxidation, and $C_5H_{10}O_7$ and $C_5H_{10}O_8$ compounds likely products of ozonolysis. The PAM oxidation experiment further demonstrates that the highly oxygenated, low-volatility products efficiently nucleate particles.

2AC.5

Effect of Aerosol Acidity on the Kinetics and Products of Heterogeneous Hydroxyl Radical Oxidation of Isoprene Epoxydiol-Derived Secondary Organic Aerosol. JIN YAN, N. Cazimir Armstrong, Alison Fankhauser, Madeline Cooke, Nicolas Aliaga Buchenau, Yao Xiao, Zhenfa Zhang, Andrew Lambe, Avram Gold, Andrew Ault, Jason Surratt, *University of North Carolina at Chapel Hill*

We recently demonstrated that the heterogeneous hydroxyl radical (·OH) oxidation is an important aging process for isoprene epoxydiol-derived secondary organic aerosol (IEPOX-SOA) that alters its chemical composition, and thus, aerosol physicochemical properties. Notably, dimeric species in IEPOX-SOA were found to heterogeneously react with ·OH at a much faster rate than monomers, suggesting that the initial oligomeric content of freshly-generated IEPOX-SOA particles may affect its subsequent atmospheric oxidation. Aerosol acidity could in principle influence this aging process by enhancing the formation of sulfated and non-sulfated oligomers in freshly-generated IEPOX-SOA. Many multifunctional organosulfate (OS) products derived from heterogeneous ·OH oxidation of sulfur-containing IEPOX-SOA have been observed in cloud water residues and ice nucleating particles and could affect the ability of aged IEPOX-SOA particles to act as cloud condensation nuclei. Hence, this study systematically investigated the effect of aerosol acidity on the kinetics and products resulting from heterogeneous ·OH oxidation of IEPOX-SOA particles.

Gas-phase IEPOX was reacted with inorganic sulfate particles of varying pH (0.5 to 2.0) in an indoor smog chamber operated under dark, steady-state conditions to form freshly-generated IEPOX-SOA particles. These particles were then aged at a relative humidity of 60% in an oxidation flow reactor (OFR) for 0-15 days of equivalent atmospheric ·OH exposure. Aged IEPOX-SOA particles were sampled by an online aerosol chemical speciation monitor (ACSM) to measure real-time aerosol mass and chemical changes of the SOA particles, and were also collected onto Teflon filters and into PILS vials for molecular-level chemical analyses by hydrophilic liquid interaction chromatography method interfaced to electrospray ionization high-resolution quadrupole time-of-flight mass spectrometry (HILIC/ESI-HR-QTOFMS), ion chromatography, and total OS mass amounts.

2AC.6

Revisiting the Simulation of Intermediate Volatility Compounds (IVOCs) in Chemical Transport Models.

STELLA EFTYCHIA MANAVI, Spyros Pandis, *University of Patras, FORTH*

Intermediate volatility organic compounds (IVOCs) are compounds with an effective saturation concentration (C^*) at 298 K between 10^3 and 10^6 μg m^{-3} and they can be an important class of secondary organic aerosol (SOA) precursors. The first implementations of SOA formation from IVOCs (SOA-iv) in chemical transport models (CTMs) were done by using the volatility basis set (VBS), a highly parametrized scheme that oversimplifies the corresponding chemistry. In this study we develop a more detailed approach for simulating both IVOC chemistry and SOA-iv formation in CTMs, by treating IVOCs as lumped species that retain their chemical characteristics.

The new approach includes seven new lumped IVOC species; four representing larger alkanes, two representing polycyclic aromatic compounds (PAHs) and one representing intermediate-length aromatics. The simulation of their gas-phase chemistry was assumed to be equivalent to that of larger alkanes and aromatics but with appropriate parameters. Recent smog chamber experimental data were used to estimate the SOA yields of the additional IVOCs under both high and low-NO_x conditions. As most emissions inventories do not include IVOCs, we estimated their emissions starting from on-road transport using existing non-methane hydrocarbons emissions and source specific emissions factors of individual IVOCs.

The new emissions and the extended mechanism were introduced to PMCAMx, a three-dimensional CTM, and used to simulate the EUCAARI intensive period. Over the European domain, for the simulated month of May 2008, estimated IVOC emissions from on-road transport were 8 times higher than emissions used in previous VBS-applications. Moreover, the predicted averaged SOA-iv concentrations increased by 58% compared to those predicted by the VBS approach. The overall role and contributions of the various IVOCs to SOA formation were also explored. Unspeciated cyclic compounds were identified as the most important precursors contributing of 78% of the total SOA-iv mass. The major remaining uncertainties are summarized.

2AC.8

Relative Humidity Enhancement of New Particle Formation for a Variety of Biogenically - Derived Secondary Organic Aerosol at Atmospherically Relevant Mixing Ratios.

AUSTIN FLUECKIGER, Giuseppe Petrucci, *The University of Vermont*

A significant portion of secondary organic aerosol (SOA) mass in the atmosphere is a direct product of volatile organic compound (VOC) oxidation. Previous studies exploring the impact of relative humidity (RH) on new particle formation (NPF) via ozonolysis of VOCs generally reported a negative correlation of NPF with RH, although some contradictory results exist. Previous studies in our laboratory with respect to α-pinene-derived NPF suggest that, while a modest decrease in NPF is observed at mixing ratios typical of laboratory studies (i.e., > 50 ppbv) at VOC mixing ratios below 10 ppbv, and at an atmospherically relevant RH of 60 %, NPF may, in fact, be enhanced significantly (up to 10-fold). Therefore, the purpose of this study is to examine the potential enhancement of NPF from the ozonolysis of a variety of VOCs (including α-pinene-derived structures) with respect to RH at varying (atmospherically relevant) mixing ratios. Preliminary work with sabinene has shown that at < 1 ppbv mixing ratios, NPF is enhanced under humid conditions compared to dry conditions (0 % RH); this is comparable to α-pinene-derived SOA. In contrast, cis-3-hexenyl acetate (CHA)-derived SOA has shown a shutdown of NPF under humid conditions under all VOC mixing ratio studies. The preliminary work completed in our laboratory suggests the impact of RH on NPF is likely driven by chemical formation, where enhancement or shutdown of particle formation is dependent on the individual VOC. Supporting evidence for chemically driven particle formation is discussed.

2AC.9

Observations of Gas and Particle Phase Composition of a-Thujene Ozonolysis Products. MICHELIA DAM, Adam Thomas, James Smith, *University of California, Irvine*

Ozonolysis (O3) of monoterpene (MT) compounds is a known major contributor to secondary organic aerosol (SOA) formation. Some of these MT + O3 systems have been widely studied (a-pinene, b-pinene, etc.), but a-thujene is a MT compound with unique structural features that we hypothesize will lead to mechanistically specific reactivity in the gas phase, forming oxidized reaction products that influence particle formation and growth. The explicit composition of a-thujene ozonolysis products has never been observed, to our knowledge. Therefore, we conducted laboratory chamber experiments to measure the gas-phase and particle-phase composition of oxidized organics from the a-thujene ozonolysis system with various concentrations of gas precursors. Gas-phase composition was measured online using high resolution time of flight chemical ionization mass spectrometry (HR-TOF-CIMS) with NO3- and I- reagent ions to probe less and more highly oxidized products, respectively. Offline particle composition was measured with an ultrahigh resolution mass spectrometry UHPLC-HRMS system with an Orbitrap mass analyzer. Additionally, particle size distributions were measured (SMPS) and new particle formation was observed under all experimental conditions except the lowest MT concentration condition. The three methods of analysis captured very different product distributions from various stages of oxidation, with C10H14O5 (I-CIMS), C5H6O6 (NO3-CIMS) and C9H14O4 (Orbitrap) identified as the most abundant species. The contribution of individual species to the overall measured signal was observed as the MT concentration was modulated. In general, increasing MT concentration resulted in an increase of observed particle concentration and highly oxidized products measured with I-CIMS and in the particle phase, but a decrease was observed with NO3-CIMS. Understanding the molecular composition of these reaction products will allow us to assess the importance of the a-thujene ozonolysis system relative to other MT systems in both ambient and relevant specific conditions, such as indoors, when high a-thujene concentrations can be observed.

2AC.10

Characterizing the Aging Rate Constant and Half-life Time of the Atmospheric Polystyrene (PS) Microplastics Particles (MPP). SAHIR GAGAN, Ruizhe Liu, Sining Niu, Zhenli Lai, Andrew Lambe, Yuzhi Chen, Xingmao Ma, Yue Zhang, *Texas A&M University*

Microplastics are an emerging class of anthropogenic pollutants that have been found in urban, suburban, and even remote areas. However, much is unknown about the life cycle of atmospheric microplastic particles (MPP), especially with regard to chemical reactivity towards atmospheric oxidants. Characterizing the lifetime of MPP may contribute towards improved understanding of their environmental persistence, health implications, and potential contribution to climate forcing. In this regard, this study provides the first measurement of the oxidation and photolysis lifetimes of polystyrene(PS), a major component of MPP, against hydroxyl radicals(·OH), ozone, and UV photons.

Atomized PS particles were introduced to a Potential Aersosol Mass (PAM) reactor in the presence of ·OH, ozone, and UVC radiation (λ=254nm). A high resolution time-of-flight aerosol mass spectrometer(HR-ToF-AMS) and a scanning electric mobility sizer(SEMS, Brechtel Inc.) were used to quantify the mass concentrations and surface areas of PS particles at different stages of aging. Decay of m/z78 and m/z104, tracer ion for PS was monitored from HR-ToF-AMS to understand the aging of PS. The degree of aging of PS particles by ozonolysis, photolysis, and ·OH oxidation were measured by varying their respective concentrations inside the PAM.

The second order rate constant of PS particle against ·OH under pseudo first order rate assumption, k_{PS}, is calculated to be 1.4×10^{-13}cm^{3}molecule^{-1}s^{-1} while the ozonolysis and photolysis rates were negligible. Our results demonstrate that the main degradation pathway for MPP in the atmosphere is likely ·OH oxidation. Assuming an ambient ·OH concentration of 1×10^6cm^{-3}, the half-lifetime of microplastic in the atmosphere is estimated to be 84 days.

This lifetime could be enough to transport MPP in upper atmosphere, resulting in long-range transportation. Such parameter also needs to be consider while developing model which simulate long-term transportation processes.

2AC.11

Measuring and Modeling Ultrafine Particle Growth by Isoprene Ozonolysis Secondary Organic Aerosol.

MICHAEL S. TAYLOR, Murray Johnston, *University of Delaware*

Through condensation and partitioning of oxidation products, biogenic volatile organic compounds (BVOC) can contribute significantly to the growth of particles in the Aitken mode size range (10-100 nm), which often represent the largest number fractions in ambient air. Understanding the mechanisms across conditions found in the environment allow for cloud condensation nuclei (CCN) to be better predicted. Monoterpenes such as α-pinene have been shown to produce a significant number of low volatility organic compounds via gas phase oxidation reactions. These products vary significantly in terms of structure, volatility, and yield, altering the SOA composition and rate of particle growth. Recent work in our group has shown seed particle size, phase, and interfacial water on the growth rate of ammonium sulfate seed particles, both through theoretical simulations and experimental measurements (Taylor Jr. et al. 2022, Higgins et. al. 2022). These studies introduce the term “growth yield” (GY), which is a measure of the molar fraction of BVOC ozonolysis products that are taken into the particle, causing it to grow. For α-pinene ozonolysis products specifically, growth on ammonium sulfate seed particles is enhanced by surface water (effloresced particles exposed to increasing RH) and especially by aerosol liquid water (deliquesced particles). Isoprene, an acyclic alkene, is known to produce a substantially lower yield of low volatility products when reacting with ozone, and therefore, the growth yield is expected to be reduced when compared to that of α-pinene. However, higher volatility products of isoprene ozonolysis can produce a significant amount of SOA from aqueous phase reactions. Here, we present results on the growth of ammonium sulfate seed particles by isoprene ozonolysis under low (10%) and high (60%) relative humidity as well as effloresced vs. deliquesced seed phases. Additionally, the effects of seed acidity are examined to elucidate how this effects growth from particle phase reactions. SMPS measurements and corresponding growth yield values will be presented and discussed.

2AC.12

The Effect of Initial Conditions on the Growth of Particulate Matter from Aromatic Hydrocarbons.

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The formation of secondary organic aerosol (SOA) from the growth of nanoparticles via the photooxidation of volatile organic compounds (VOCs) is of great atmospheric importance, due to their being a significant source of cloud condensation nuclei (CCN)-active particulate matter. An increasing prevalence of human industrialization since the beginning of the Industrial Revolution has led to increased interest in the effects of industrial emissions on these atmospheric processes. Despite contributing a minor fraction of total VOC content in the atmosphere and being relatively localized in nature, VOCs of anthropogenic origin (AVOCs) are of increasing interest due to their ability to both generate their own SOA while simultaneously influencing the SOA generated from their biogenic counterparts.

One of the most common classes of AVOCs present in the atmosphere is the aromatic class, capable of generating the low-volatility products found in SOA and whose preferential diurnal photooxidation mechanism involves the hydroxyl radical (·OH). A custom flow-tube type photooxidation reactor with desirable flow characteristics is used to generate the SOA while approximating real-world precursor concentrations. Previous work has established that particle-phase reactions occurring within generated SOA plays a key role in the growth of atmospheric nanoparticles, both using reactive and inert seeds as a growth substrate, and using a scanning mobility particle sizer (SMPS) to elucidate changes in aerosol mobility diameter. The work presented here compares the diameter growth rates of aerosol produced from the photooxidation of aromatic hydrocarbons onto different composition seed particles having a range of sizes within the Aitken mode (10-100 nm). The relative humidity during these experiments is controlled to compare solid-to-aqueous seed surface conditions on aerosol growth. Understanding the mechanisms through which SOA from AVOCs grows across the Aitken mode becoming CCN-active is invaluable to understanding the effects that our activities have on global climate.

2AC.13

Identifying the Temporal Change and Impact of Liquid Water Content, Acidity, and Meteorological Conditions on Fine Particle Concentration and Composition in San Antonio, Texas.

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Two field studies were conducted near downtown San Antonio in May 2017 and April-May 2021. Results from a high-resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS) indicated large organic (5.89±3.46 and 7.19±3.94 μg m^{-3} in 2017 and 2021, respectively) and sulfate (3.55±2.46 and 5.11±4.80 μg m^{-3}) contributions to the total non-refractory submicron particulate matter (NR-PM_1). Two-day backward trajectories were clustered into "Oceanic," "Coastal" and "Continental" scenarios for each campaign. In 2017, increased NR-PM_1 was observed in Oceanic scenarios, driven by sulfate (4.87±2.64 μg m^{-3}) and ammonium (1.57±0.84 μg m^{-3}). These sulfate and ammonium concentrations are three times as large as in Continental scenarios (1.66±0.56 and 0.55±0.23 μg m^{-3}, respectively), with those in Coastal scenarios in the middle (2.66±0.98 and 0.88±0.31 μg m^{-3}, respectively). Organics were relatively consistent, slightly increasing from 5.74±3.67 μg m^{-3} in Continental scenarios to 6.25±3.91 μg m^{-3} in Oceanic scenarios. In 2021, sulfate and ammonium also increased from Continental scenarios (2.75±1.91 and 1.08±0.68 μg m^{-3}) to Oceanic scenarios (8.08±5.70 and 3.08±2.13 μg m^{-3}), but the organics showed a stronger decrease from 8.45±4.13 μg m^{-3} to 6.50±3.45 μg m^{-3}. Using ISORROPIA-II, we investigated the change in aerosol liquid water content (LWC) and acidity. In both years, LWC decreased from Oceanic scenarios (7.89±6.07 and 13.53±10.44 μg m^{-3} in 2017 and 2021, respectively) to Coastal scenarios (3.62±3.14 and 10.46±6.25 μg m^{-3}) and further to Continental scenarios (1.25±1.01 and 3.34±3.71 μg m^{-3}), while inorganic aerosol pH indicates that NR-PM_1 became more acidic. Compared to 2017, increased LWC and decreased acidity were observed in all scenarios in 2021. Further analysis will be performed to investigate different sources/formation pathways of NR-PM_1 and how air mass history, meteorological factors, and chemical processing impact its level in San Antonio.

2AC.14

The Fate of RO2 Radicals from α-Pinene and Naphthalene Precursors under Constant Branching Ratio with Continues NOx Injection.

SAHAR GHADIMI, David R. Cocker III, *University of California, Riverside*

The fate of gas-phase organic oxidation reactions is dependent on a large number of branching ratios within each molecule's reaction mechanism. Branching ratio, ß, is defined as the fraction of organic peroxy (RO_2) radical consumption by NO, which depends on NO_x conditions. Indeed, RO_2 radicals can react bimolecularly with NO_x, HO_2, other RO_2 or undergo unimolecular rearrangement, which results in different secondary organic products with different volatility. For instance, during the photo-oxidation of biogenic compounds, low vapor pressure species formed in peroxide rich (low-NO, low ß) conditions favor RO_2+HO_2 reactions, and organic nitrates form in higher NO_x (higher ß) environments by favoring RO_2+NO reactions.

SOA yield from α-pinene and naphthalene is evaluated in this work in a new 118 m^3 fixed-volume environmental chamber at UCR/CE-CERT. The SOA yield experiments were conducted at fixed ß, which were controlled via continuous NO_x injection designed using SAPRC-11 simulation.

The SOA formation results are compared to classical experiments in which the NO_x is added instantaneously at the beginning of the experiment. It is observed that the SOA yield was substantially suppressed for high ß conditions for both the monoterpene and the polycyclic aromatic hydrocarbon. Moreover, the continuous NO_x injection method (constant ß) revealed lower SOA yield than variable ß (traditional VOC-NOx) experiments at lower initial hydrocarbon (HC) concentration and higher SOA yield at higher HC conditions.

2AC.15

Ultrafine Aerosol Particle Formation and Impacts in Houston during TRACER. JEREMY WAKEEN, Xuanlin Du, Sam O'Donnell, Jeffrey R. Pierce, Don Collins, James Smith, *University of California, Irvine*

New particle formation (NPF) events have been observed in Houston during the summertime, but there are a lack of studies focusing on the gaseous precursors and chemical composition of newly formed particles in this region. Here we describe initial results from the Tracking Aerosol Convection Interactions Experiment-Ultrafine Aerosol Formation and Impacts (TRACER-UFI) campaign, which took place at the La Porte Municipal Airport in La Porte, Texas, from July 1st to August 31st, 2022. The objectives of TRACER-UFI are to understand the chemical species and mechanisms responsible for the formation of ultrafine (sub-100-nm diameter) particles in the Houston atmosphere. Our approach combines direct measurements of low-volatility precursors and size-resolved ultrafine particles together with measurements of gas-particle partitioning of ambient vapors onto size-selected nanoparticles of known composition, the latter using the UC Riverside Captive Aerosol Growth and Evolution (CAGE) chamber. Our measurements will ultimately be coupled with modeling and co-located measurements of particle hygroscopic properties in order to infer the impacts of ultrafine particles on clouds and climate.

During TRACER-UFI, we measured the composition of ambient 30-60 nm diameter particles using Thermal Desorption Chemical Ionization Mass Spectrometry (TDCIMS) as well as the concentration of ambient Highly Oxidized Molecules (HOMs), including sulfuric acid, with nitrate-CIMS. Ambient measurements were alternated with measurements of gases and particles participating in NPF and either directly nucleating or partitioning onto 30 nm diameter ammonium sulfate seed particles using CAGE. During the daytime, we observed nucleation and nanoparticle growth each day with or without seed particles, suggesting that conditions exist to produce low-volatility HOMs that, under conditions of low condensation sink, would result in ambient new particle formation and growth events. Initial measurements by the TDCIMS and nitrate-CIMS indicate significant amounts of sulfate and sulfuric acid in ambient nanoparticles and air, respectively.

2AC.16

Effects of Wet Removal on Aerosol Mass and Chemical Composition. CHRISTOS STAMATIS, Graham Frazier, Raina Lenear, Gabriel Isaacman-VanWertz, *Virginia Tech*

A substantial fraction of secondary organic aerosol (SOA) is formed through the multigenerational oxidation of reactive organic gases. Therefore any processes such as wet and dry deposition that remove gases, in particular lightly oxidized and/or condensable gases, will affect the thermodynamic equilibrium and thus the formation and concentration of SOA. Unfortunately, the few direct observational constraints on the fate of oxygenated gases and particles and the timescales of wet removal lead to significant uncertainty in effects of precipitation on aerosol formation and properties. In this work we will present preliminary findings from the analysis of particle and precipitation size distribution data from several globally distributed sites in the Department of Energy Atmospheric Radiation Measurement (ARM) network as well as data from collocated measurements of wet scavenging of particles and gases collected in Blacksburg, Virginia using a semi-volatile thermal desorption aerosol gas chromatograph (SV-TAG) and laser disdrometer. Studying the real-world measurements from these diverse geographical locations will lead to an improved understanding of how precipitation affects aerosol chemical properties and mass as well as reduce uncertainties in regional and global models by introducing improved constraints on wet deposition of oxygenated gases.

2AC.17

Trapped in the Inversion Layer: Composition and Morphology of Single Aerosol Particles in the Urban Arctic Winter. EMILY COSTA, Jessica Mirrielees, Jessie Creamean, Andrew Holen, Judy Wu, Swarup China, Kerri Pratt, *University of Michigan*

Air pollution in Arctic cities is a critical yet often overlooked problem. Atmospheric inversion layers can lead to the accumulation of pollutants over time, resulting in levels of airborne particulate matter that often exceed air quality standards. These temperature inversions can also result in the formation of ice fog, a hazardous form of air pollution that occurs at low temperatures as small ice crystals with low gravitational settling rates remain airborne for extended periods of time. Aerosols known as ice nucleating particles (INPs) can contribute to ice fog formation; however, many questions remain due to the limited observations of these processes. The composition and chemical transformations of aerosols in this region are not well characterized. To better understand wintertime urban air quality, aerosol particle samples were collected during January-February 2022 during the Alaskan Layered Pollution and Chemical Analysis (ALPACA) field campaign in Fairbanks, AK. Individual particles are analyzed using scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDX) to study their morphology and elemental composition. The types of aerosols present in the polluted city of Fairbanks and during ice fog events are characterized using these size-resolved chemical composition data. This method provides identification of the main components and sources of wintertime aerosol particles in Fairbanks impacting ice fog formation and air quality.

2AC.18

Particle-phase Diffusion Limitations in Fresh Isoprene Secondary Organic Aerosol. YUZHI CHEN, Rahul Zaveri, Zezhen Cheng, Gregory Vandergrift, Swarup China, Alla Zelenyuk, John Shilling, *Pacific Northwest National Laboratory*

Environmental chambers have been conventionally used to investigate secondary organic aerosol (SOA) formation and generate model-ready parameterizations based on semivolatile equilibrium partitioning theory, which have successfully improved the prediction of SOA formation and evolution in atmospheric models. However, recent studies have shown that traditional equilibrium partitioning theory fails to predict SOA mass generated from oxidation of binary or more complex precursor VOC mixtures. Our previous experimental work has shown that fresh isoprene SOA would not rapidly partition into α-pinene SOA and isoprene SOA that are aged for 15−18 hours (at an OH concentration of ~ 2×10^6 molecules/cm^3) as equilibrium partitioning theory would predict, even under humid condition (RH ~ 70%). In this study, we probed the aging time scale required to trigger mass transfer limitation of semivolatile compounds partitioning between the gas- and aerosol-phase. Isoprene SOA seed was prepared by irradiating gas-phase isoprene and H_2O_2 in the presence of dry ammonium sulfate seed in the PNNL environmental chamber at ~ 23 °C and RH ~50%. Once the initial isoprene SOA growth peak was attained, isoprene SOA was aged under either light or dark for 0 – 6 hours, followed by a second photochemical growth period with injection of additional isoprene vapor. Surprisingly, equilibrium partitioning overpredicted the observed SOA yield when we assumed the fresh SOA is soluble in the aged SOA seed for the second photochemical growth period regardless of the aging time and irradiation condition. A box model was used to further investigate the cause of observed mass transfer limitation and showed that a semi-solid phase had to be assumed by the model to reproduce the observed evolution of particle size distribution. Filter samples were also collected and analyzed offline by nanospray desorption electrospray ionization mass spectrometry (nanoDESI-MS) to elucidate the changes in molecular-level chemical composition pertaining to the changed aerosol phase state.

2AC.19

Formation of Reactive Oxygen Species in Irradiated Mixtures of Biomass Burning Compounds. LENA GERRITZ, Jinlai Wei, Sergey Nizkorodov, Manabu Shiraiwa, *University of California, Irvine*

In recent years, the frequency and intensity of wildfires has increased, resulting in a need to understand the impact of biomass burning events such as the formation of reactive oxygen species (ROS) and organic radicals through the photochemical processes. Due to the complex composition of naturally formed biomass burning organic aerosol (BBOA) particles, previous research has limited understanding of the specific chemical reactions taking place within aqueous BBOA. The goal of this work is to use surrogate mixtures of benzoquinone and levoglucosan to elucidate the ROS formation kinetics and organic radical product composition from one reaction channel likely to be found in BBOA. The surrogate mixtures were prepared and then irradiated using a 100 W Mercury UV lamp and the ROS and organic radical formation was monitored using Electron Paramagnetic Resonance (EPR) spectroscopy over the time span of an hour. The mixtures were also analyzed using ultra-high-performance liquid chromatography coupled with high resolution mass spectrometry (UPLC-HRMS) to characterize the composition of the mixtures before and after irradiation at different concentrations of levoglucosan. We conduct further analysis by kinetic modeling to simulate the ROS formation kinetics. The ROS formed by benzoquinone reacted with levoglucosan to produce secondary free radicals. These results help interpret the transformation of BBOA compounds through cloud and fog processing.

2AC.20

Effect of Product Cross-Reactions from Oxidation of Cyclic and Acyclic Monoterpene Mixtures on Secondary Organic Aerosol. SIJIA LIU, Sergey Nizkorodov, Celia Faiola, *University of California, Irvine*

Plants produce up to 1 million secondary metabolites that function in growth, defense, and reproduction. Biogenic volatile organic compounds (BVOCs) are the metabolites emitted from plants to the atmosphere. The shifting of BVOC emission profiles in stressed environments (e.g., drought, herbivory and pollution stress) changes chemical composition, hygroscopicity, and optical properties of SOA formed fr, prompting the change in aerosol climate effects. Previous studies have investigated aerosol chemistry extensively using a single reference compound, such as α-pinene to represent a conifer system. In this study, photooxidation of mixtures of cyclic (limonene) and acyclic (b-myrcene) monoterpenesare used to probe the effect of RO2-RO2 cross-reactions on SOA composition and properties. SOA was prepared in a smog chamber from mixtures representing a range of reactivity ratios of myrcene/limonene while keeping the overall OH reactivity constant. The chemical composition of gas-phase SOA precursors was analyzed using proton-transfer reaction time-of-flight mass spectrometry (PTR-ToF-MS) and thermal desorption–gas chromatography–mass spectrometry (TD-GC-MS). The physico-chemical properties of SOA were measured using a scanning mobility particle sizer (SMPS), and offline ultra-high performance liquid chromatography coupled to high-resolution mass spectrometry (UHPLC-HRMS). The preliminary data suggest that mixtures with higher myrcene/limonene reactivity ratios have higher dimer/monomer ratios in the SOA particles. The inferred volatility for the systems dominated by myrcene (>50%reactivity) is also lower compared to the mixtures dominated by limonene (>50% reactivity). The results are unexpected because acyclic terpenes should fragment more compared to cyclic terpenes during oxidation. Potential chemical mechanisms resulting from the interaction between acyclic/cyclic terpene oxidation products will be presented. This study will provide information to improve predictions of biogenic SOA formation from complex plant emission mixtures.

2AE.1

Pesticides Concentrations in the Atmosphere of an Urban Area in Brazil - Risk Assessment for Human Health.

ALEINNYS YERA, *University of São Paulo*

In the last few years, different types of pesticides have been detected in the atmosphere in rural and urban areas around the world. These, are chemical compounds used in agriculture to avoid the plague, rodents, fungi, and unwanted plants. Besides that, they are often used in public health to kill vectors of disease, such as mosquitoes. Some studies have shown the relationship between pesticide exposure and some diseases, such as autoimmune and cardiovascular diseases, and respiratory problems. An attempt to investigate the composition of PM in the neighboring atmosphere of an industrial complex has been proposed in the last few years due to the high rate of thyroid diseases in the population living near this region. In this work was determined the concentrations of pesticides in samples collected between 2015, 2016, and 2017 in an industrial and urban area. The assessment of the risk caused by the inhalation of these compounds was calculated. Samples (n=42) were extracted and 11 pesticides were determined by gas chromatography coupled to a mass spectrometer. Samples collected in 2017 showed higher concentrations. Pesticides such as malathion and permethrin, used in the control of domestic pests, presented the highest concentrations (537 pg m^{-3} and 625 pg m^{-3} respectively) due to their wide use in this area. The highest values of daily inhalation exposure were for heptachlor in infants, 2×10^{-4} mg kg^{-1} day^{-1}. All values of the hazard quotients are lower than 1.0 indicating that there is no danger to human health by inhalation. Cancer risk was found for heptachlor in adults, infants, and children in the three years.

2AE.2

Occupational Exposures from Fish Smoking in Coastal Ghana.

CHERYL WEYANT, Antwi-Boasiako Amoah, Ashley Bittner, Joseph Pedit, Samuel Codjoe, Pamela Jagger, *University of Michigan*

Occupational exposures in low-income countries are understudied and the associated health burdens likely under-counted. Brick making, charcoal production, food processing, and industrial cooking are common occupations in low-income countries that have significant combustion particulate matter ($PM_{2.5}$) exposure. To explore occupational exposures, we conducted a case-comparison study of 308 women who are occupational fish smokers and 152 women in other occupations (i.e. business, trade, or other jobs in the fishing industry) from the same communities in coastal Ghana. $PM_{2.5}$ and carbon monoxide (CO) were measured in a subset of the women (N = 26 and N = 152, respectively) for 24 hours during normal activities. Both $PM_{2.5}$ and CO exposures were more than doubled for fish smokers (490 vs. 190 μgm^{-3} for $PM_{2.5}$ and 6.6 vs. 3.0 ppm for CO). All $PM_{2.5}$ exposures were above the annual WHO safe guideline (10 μgm^{-3}) and 92% were above the interim guideline (35 μgm^{-3}). $PM_{2.5}$ exposures for fish smokers were four times greater than typical from household cooking with wood in Ghana. Even non-fish smokers had higher exposure than typical from cooking (2.6 times greater for CO and 1.5 times for $PM_{2.5}$), suggesting that fish smoking increases local ambient pollution. Better fish smoking ventilation would reduce exposure for workers; women who used open air smokers were exposed to less than half the CO compared to those using indoor smokers (5.6 ± 5.4 ppm compared to 12.0 ±10.0 ppm, p = 0.01). Fish smokers had significantly more respiratory and neurological symptoms and reduced vision compared to other local women. Nearly 50% of fish smokers could not see well enough to conduct normal activities (16% in women not engaged in fish smoking). Fish smoking is one of many occupations that uses polluting fuels and has high exposures for workers and surrounding communities.

2AE.3

LPG Cooking as a Replacement for Charcoal: Impacts on Exposure to PM2.5 and Carbon Monoxide in Rwandan Homes.

CHERYL WEYANT, Joseph Pedit, Ashley Bittner, Sudhanshu Handa, Leena Nylander-French, Karin Yeatts, Pamela Jagger, *University of Michigan*

Exposure to pollutants from residential cooking with solid fuels (such as wood or charcoal) is a major cause of illness and mortality, in the Global South. Many households are transitioning away from these fuels and adopting clean fuels, such and liquefied petroleum gas (LPG) and electricity for some or all of their cooking. However, these transitions are rarely closely observed outside of a trial or intervention. We conducted a five-panel observational study, where households were surveyed five times over six years, to study household fuel transitions in Gisenyi, Rwanda. From 2015 to 2020, LPG use grew from 5% to 42% of households. Over this transition, we measured 24-hr exposure by household cooks to particulate matter $PM_{2.5}$ (N = 655) and carbon monoxide CO (N = 3,322) for households with a range of LPG use (0-100% of meals). Both CO and $PM_{2.5}$ exposures were lower in households that used LPG compared to other households (where charcoal was predominate and some biomass pellets were used). On average, households that used LPG, used it for 56% of their meals, with moderate, but significant, growth over time. Few households were exclusive users; most continued to use some charcoal. Even those that used LPG nearly exclusively (90-100% of meals), had $PM_{2.5}$ exposures above healthy recommended levels (58 μgm^{-3}), likely from other sources as indicated by ambient measurements. Despite the high $PM_{2.5}$ exposure in LPG users, it was a significant improvement from charcoal cooking and likely to result in health improvements.

2AE.4

Concentration and Oxidative Potential of Fine Particulate Matter at the Major US-Mexico Port of Entry San Ysidro/El Chaparral.

RITA ZURITA, Penelope Quintana, Yanis Toledano-Magaña, Fernando Wakida, Lupita Montoya, Javier Castillo, *Universidad Autónoma de Baja California, México*

Epidemiological studies have reported adverse health effects of traffic-related air pollutants and roadway particulate matter (PM) has been shown to generate reactive oxygen species leading to oxidative stress. The dithiothreitol (DTT) assay is commonly used to determine the Oxidative Potential in PM (OP^{DTT}). The San Ysidro/El Chaparral Land Port of Entry (SYPOE), located between San Diego, US, and Tijuana, Mexico, is the busiest border crossing in the Western hemisphere. The objective of this study was to measure $PM_{2.5}$ concentrations and the associated OP^{DTT} from samples collected at the SYPOE. Black Carbon (BC) concentrations were also measured and the associated BC inhalation dose was estimated for pedestrians crossing the SYPOE.

Sampling took place in Tijuana, B.C., Mexico, about 200 m southeast of the SYPOE and from 2017 to 2019. $PM_{2.5}$ sampling was conducted following published Standard Operating Procedure MDL016. OP of $PM_{2.5}$ was determined using the DTT assay. BC concentrations were measured using a portable micro Aethalometer (Aeth Labs, AE51, California, US) and then used to estimate BC inhalation doses. Results showed that $PM_{2.5}$ concentrations exceeded the World Health Organization guideline (10 $\mu g\ m^{-3}$) about 64% of the sampling period. It was also determined that $PM_{2.5}$ and BC concentrations were higher during lower wind speeds. The OP^{DTT} was highest in winter, with a value of 18.5 pmol $min^{-1}\ \mu g^{-1}$ (0.6 nmol $min^{-1}\ m^{-3}$) and during longer waiting times. The highest BC inhalation dose estimated for pedestrians was in autumn (7.0 µg/ 60 min wait time). Decreasing the waiting time for vehicles to cross the border would impact the exposure and the inhalation dose of both workers and people crossing the border. Studies that evaluate the composition of $PM_{2.5}$ collected at such locations are necessary to better understand the negative effects they could have on the health of the affected populations.

2AE.6

In Vivo Monitoring Air Pollution Health Impacts using Breath-borne VOCs. LU ZHANG, Xinyue Li, Haoxuan Chen, Zhijun Wu, Min Hu, Maosheng Yao, *Peking University*

Direct observation of air pollution health impact on humans is difficult and lacking. Here, we investigated the use of breath-borne volatile organic compounds (VOCs) for in vivo monitoring air pollution health effects on humans. Forty-six healthy college students were recruited; and their exhaled breath samples (n=235) were collected and analyzed for VOCs before, on and after two separate haze pollution episodes using Gas Chromatograph-Ion Mobility Spectrometer (GC-IMS). Paired t-test and machine leaning model (Gradient Boosting Machine, GBM) were conducted to discriminate the VOC profiles of pre-, on- and post-exposure to haze pollution. Six exhaled VOC species including propanol and isoprene were detected to differ significantly among pre-, on- and post-exposure in both haze episodes; while no statistically significant differences were found between clean control days ($p\text{-value}>0.05$). GBM model was shown to differentiate pre- and on-exposure to haze pollution for both haze episodes with a precision of up to 90-100%. However, the same model had poor performance of differentiating the differences in breath-borne VOC profiles between two different clean days. Correlation analysis revealed that NH4+, NO3-, acetic, mesylate, CO, NO2, PM2.5, and O3 played important roles in the changes of breath-borne VOC fingerprints following haze pollution exposure. Results not only showed a gender difference in response to the haze pollution, but also different health impacts from different haze episodes. This work has demonstrated direct evidences of human health impacts of haze pollution, while developing a protocol for non-invasively in vivo tracking the impacts of air pollution on human health.

2AE.7

Potential for Exposure to Toluene Secondary Organic Aerosol and Health Effect. HYEON-JU OH, Jiwoo Jeong, Yanfang Chen, Hwajin Kim, *Seoul National University*

Secondary organic aerosols (SOAs), the major components of fine particle contamination ($PM_{2.5}$), are currently receiving considerable attention as those cause lung and heart problems and other health effects. In particular, toluene emitted from automobiles is the most abundant aromatic compound in the atmosphere and is an important precursor of SOA. This study evaluates SOA exposure generated on the roadside and its potential health effects using a reaction model of toluene photooxidation within a reaction chamber. Scanning Mobility Particle Sizer (SMPS) was used for quantitative exposure evaluation of SOA produced by toluene photooxidation with different NOx concentrations (max. 70ppb). The health effects of aerosol induced by the toluene-SOA were simulated by the modeling methods of the International Commission on Radiological Protection (ICRP) and Multiple-Path Particle Dosimetry (MPPD). The average mass concentrations and the average number concentration of produced SOA were within 120.63–225.64 $\mu g/m^3$ and 5.28×10^4–1.11×10^5 $\mu g/m^3$, respectively. The SOA reached maximal mass concentration at about 2 hours post toluene injection and maintained the same level thereafter. Although the yield of SOA increased with the NOx concentration, the SOA number concentration decreased, which is attributed to particle agglomeration and wall loss in the chamber. Using the result of SOA mass concentration in the chamber, the inhalable aerosol doses were 2,470–4,620 ng/kg-bw/application in the ICRP model, and the deposited aerosol was 500–900 ng/kg-bw/application in the MPPD. Of the aerosol deposit, 34.0% were deposited in the head airways, 42.6% in the alveolar, and 23.5% in the tracheobronchial regions. This study shows the potential health effect of toluene-SOA, an ultrafine aerosol, mediated by toluene as a precursor. Therefore, further studies are needed to investigate the physicochemical/cytological properties of toluene-SOA and other precursors of SOA in the air environment.

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2AE.8

Myth Versus Reality: Assessment of Ambient Air Quality as a Proxy for Personal Exposure for Health Risk Assessment in an Urban City of Hot Arid Climate - Doha, Qatar. Maryam Yousuf Al-Shamlan, Tamer Nada, Abadllah J Alahmadi, Mohamed Salah Osman, AZHAR SIDDIQUE, *QEERI, Hamad Bin Khalifa University, Doha, Qatar*

World Health Organization (WHO) fact sheet 2018 reported that air quality is one of the top health risks, and European Environment Agency (EEA) in 2019 declared ass the single most considerable environmental health risk in Europe, causing premature death. Long-term and short-term health impacts of air quality are primarily based on ambient air quality measurements used as a proxy of population exposure. Middle Eastern region climate is characterized by extreme hot and dusty weather along with rapid economic growth, where people live and spend about 80%-95% of their time indoors. Therefore, misclassifying health impacts from ambient air pollution exposure compared to personal exposure can mislead intervention and air quality management strategies. This is the first preliminary study reported in Qatar (Middle East), where personal exposure (PE) to air pollutants by fine & ultra-fine particulate matter and black carbon measurements were monitored in different microenvironments, i.e. Home, Office, traveling, and time spent outside. The preliminary study revealed that personal exposure (PE) to fine particulate matter in Qatar is significantly lower than ambient exposure (AE), and a weak correlation of 0.52 was observed. PE to pollutants significantly depends on personal activity patterns and air conditioning-ventilation systems. Outcomes of the study also stress further detailed investigation studies to assign the correct exposure levels for health risk assessment and policy interventions.

2AE.9

Global vs. Local Dose Deliveries of Airborne Particles through Dosimetric Aerosol in Vitro Inhalation Device (DAVID). SRIPRIYA NANNU SHANKAR, Amber O'Connor, Eric Le, Kiran Mital, Alex Theodore, Tara Sabo-Attwood, Gregory S. Lewis, Arantzazu Eiguren-Fernandez, Chang-Yu Wu, *University of Florida*

Aerosol particle deposition in human respiratory system depends on particle characteristics and the respiratory mechanics of an individual. Based on the deposition pattern of particles in the respiratory tract, local and global doses can vary which thus affect the health effects. It is hence critical for *in vitro* exposure systems to represent different patterns of particle deposition while assessing the impact of airborne particles. In this study, the collection unit of Dosimetric Aerosol in Vitro Inhalation Device (DAVID) was modified to facilitate annular deposition of airborne particles onto A549 cells cultured at air-liquid interface (ALI) by rotating the collector wells using an external worm gear motor, in addition to focused spot deposition. Copper oxide (CuO) nanoparticles suspended in ethanol (0.1, 0.5, 1 and 10 mg/mL) were used to generate aerosols using a Collison nebulizer (5 LPM). The aerosols were then diluted with 15 LPM of compressed air and collected by DAVID at 4 LPM, for 15 min. Analysis of the delivered particles by Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES) following acid digestion revealed global doses ranging from 27±2 to 467±27 $\mu g/cm^2$, while the local doses ranged between 99±6 and 2814±163 $\mu g/cm^2$. Statistical analysis of global doses by ANOVA showed there was neither a significant difference between deposition patterns nor between replicate wells, for nebulizer suspensions of 0.1-1 mg/mL. However, the spot deposition resulted in a dose ~1.6 times of the annular deposition for 10 mg/mL. In comparison, there was a significant difference between patterns and replicate wells for local doses with nebulizer suspensions 0.1-10 mg/mL. The ratio of local dose delivered as spots was ~1.7 times of annular deposition for 0.1-1 mg/mL, while it increased to ~2.6 times for 10 mg/mL. The study highlights the importance of global and local doses in dosimetry, and the need for assessing cellular response with respect to the same.

2AE.10

Ultrafine Particle Concentrations Downwind of Engineered Vegetation Belts along Highway Noise Barriers. ZHIYAO LI, Maryssa Loehr, Daniel Fleischer, Brent Bucknum, Ray Yeager, Aruni Bhatnagar, Jay R. Turner, *Washington University in St. Louis*

Computational fluid dynamics modeling suggests vegetation belts–alone or in tandem with noise barriers–can reduce ultrafine particle (UFP) concentrations downwind of major roadways. Prior measurement studies provide limited evidence for UFP reductions and more studies are needed to establish a firmer scientific basis for the design and implementation of engineered vegetation belts. *Green Heart Louisville* features an extensive neighborhood greening intervention in a Louisville, KY neighborhood to examine the relationships between urban greenness and cardiovascular health. Vegetation belts were installed adjacent to noise barriers lining a limited access highway bisecting the study area. A series of multi-day field campaigns were conducted to measure ultrafine particle (UFP) concentrations in the study area. For each measurement period, up to three vehicles were equipped with Mixing Condensation Particle Counters (vibration stabilized version of the Brechtel Model 1720 MCPC) and these platforms were used to conduct short-term stationary monitoring on roads just outside the vegetation belt/noise wall and mobile “creeping speed” monitoring on additional nearby streets. We operationally define UFP as the total particle number concentration measured by the MCPC. For crosswind conditions, preliminary results demonstrate ~15% reduction in UFP immediately downwind of a vegetation belt/noise wall combination compared to an adjacent unplanted section (i.e. noise wall only). Data analyses for other wind conditions and measurement strategies are underway and will also be presented.

2AE.11

Revisiting Particle Emissions from Heated Cooking Oils. Mostafa Salmanimojaveri, Tomiris Madiyarova, Nadezhda Ushakova, Motahareh Naseri, Karina Yessengaziyeva, Gulnur Sultanova, Enoch Adotey, Milad Malekipirbazari, Farzaneh Jafarigol, Gulnaz Zhemeney, MEHDI AMOUEI TORKMAHALLEH, *University of Illinois at Chicago*

Indoor air quality is important because people spend most of their time in their dwellings. Cooking oil particles can adversely affect human health due to the release of mutagens and carcinogenic particles such as polycyclic aromatic hydrocarbons (PAHs). This study investigated the particle number size distribution and emission rates of 17 commercial cooking oils including avocado, canola, coconut, corn, olive, peanut, vegetable, grapeseed, hazelnut, macadamia, almond, sunflower, safflower, flux, walnut, pumpkin seed and sesame oils . The experiments were conducted in a confined balcony that was well-mixed. The oils were heated in an 800 ml glass beaker (9.5 cm in diameter) on a hotplate. The empty beaker was heated continuously by the hotplate until zero emission was obtained. Then, the oil was added to the heated beaker. The oil temperature increased until it reached 195oC and heating continued for an additional 20 minutes. A Scanning Mobility Particle Sizer (SMPS), TSI, USA was used to investigate the particle number size distributions from 10nm to 400nm. The sampling tubing of the SMPS was placed at the upper surface of the beaker. A Condensation Particle Counter (CPC) (Model 3007, TSI, USA) was used at the middle of the balcony to measure the particle number concentrations (>10nm). The emission rates estimated by SMPS were the average of 3 to 5 replications and 8 replications by CPC. Sesame (1.67×1010±1.22×1010#/min), grapeseed (2.04×1010±1.09×1010#/min), pumpkin (3.18×1010 ±1.82×1010#/min) and macadamia (3.02×1010 ±2.81×1010#/min) oils were the low emitting oils while peanut (1.49×1011 ±9.34×1010#/min), olive (1.49×1011 ±1.61×1010#/min), sunflower (1.14×1011±8.67×1010 #/min), safflower (1.08×1011 ±9.08×1010#/min) and avocado (1.07×1011 ±7.06×1010#/min) oils were the high emitting oils while when CPC data were used to estimate the ER. When SMPS data were used, grapeseed (7.51×1010±5.43×1010 #/min) were the low emitting oils while peanut (4.59×1015 ±3.89×1010#/min), olive (7.1×1015 ±7.14×1010#/min), flax (7.08×1015 ±7.59×1010#/min) and vegetable (4.31×1015±3.78×1010 #/min) oils were among the high emitting oils while. The rest of the oils were middle emitting oils. Given the two group of results, peanut and grapeseed were concluded to be the highest emitting cooking oils in this study for particles larger than 10nm and at temperatures up to 200oC.

2BA.1

Comparison of Airborne Bacterial Diversity Collected by Passive and Active Air Sampling at Puy de Dôme, France.

Kevin Dillon, Romie Tignat-Perrier, Muriel Joly, Sydonia Manibusan, Vincent Darbot, François Enault, Catherine Larose, Pierre Amato, GEDIMINAS MAINELIS, *Rutgers, The State University of New Jersey*

Aerosols containing bacteria (bioaerosols) can have impacts on atmospheric processes, as well as ecosystem and human health. Common methods to collected bioaerosols include impaction, liquid impingement, filtration, and electrostatic precipitation. These methods are used by active samplers that require power, but this requirement can represent a major constraint in field studies. Alternatively, passive samplers do not require power and can operate for long times. In this study, the Rutgers Electrostatic Passive Sampler (REPS), which captures particles by electrostatic attraction and gravitational settling, was deployed at the summit of Puy de Dôme (1465 m a.s.l., France) alongside an active PM10 sampler (~1000 L/min) collecting aerosols on a quartz fiber filter. The diversity of the airborne bacteria captured by both samplers across six weekly sampling periods was examined by 16S rRNA gene amplicon sequencing. The dominant phyla observed by both samplers were similar and included Firmicutes, Proteobacteria, and Actinobacteria. Overall, 12-63% of the total bacterial richness at the genus level was shared between the two samplers, depending upon a paired sample, i.e. sampling week. The dominant genera, including Lysinibacillus and Sphingomonas, were detected by both the active sampler and REPS, although their relative abundances for each paired sampler varied. The observed bacterial richness and diversity, as estimated through Shannon's and Simpson's indexes, were significantly greater in REPS samplers compared to the filter samples. The differences in diversity at the OTU level were not accounted for due to sampling week or local meteorological conditions. The results suggest that REPS could be used for simple and convenient sampling of bioaerosols, especially in remote areas and other locations with limited power access. Its data not only complement results obtained by active samplers but also provide additional insights.

2BA.2

Passive Sampling to Track Pollen Concentration Across Urban and Rural Areas.

CHAMARI MAMPAGE, Lillian Jones, Emma Schopen, Rachel Larson, Heather Sander, Thomas Peters, Elizabeth Stone, *University of Iowa*

Pollen grains can trigger allergy reactions that exacerbate respiratory diseases. To assess the exposure risks, it is important to understand the spatial distribution of allergenic pollen in the environment. Traditional pollen counting methods typically use one location to reflect the pollen concentration in larger areas. The current study uses a novel, scalable, low-cost passive sampling technique to evaluate the distribution of pollen across urban and rural landscapes during weed pollen season in Iowa. Two microscopic slides mounted on custom-made slide holders placed inside a passive shelter were deployed at 34 sites around Johnson County, Iowa. These sites were located nearby wooded areas, a reservoir, non-paved roads, prairies, recreational, institutional, or residential areas. Two-week integrated samples were collected in August-September 2021. Pollen concentrations in each location were assessed using the flux of pollen grains on to the deposition surface and estimated deposition velocity of pollen grains. Clumped pollen grains were observed in all samples and were explicitly treated in estimating the atmospheric pollen grain concentrations. Preliminary analysis of the samples showed that the fraction of pollen in clumps ranged from 0.04 - 0.34. Pollen grain concentrations were in the range of 32 - 2100 grains m^{-3} with an average concentration of 280 grains m^{-3}, with the highest recorded concentration occurring near a prairie. Further analysis is underway to understand the spatial distribution of pollen concentrations across different landscapes and exposure variability with land use, vegetation, and population socioeconomic attributes.

2BA.3

Continuous Fluorescent Bioaerosol Measurements for 18 Months Combined with Filter Sampling Validation.

MADELEINE PETERSSON SJÖGREN, Jonas Jakobsson, Malin Alsved, Thomas Bjerring Kristensen, Tina Santl-Temkiv, Jakob Löndahl, *Lund University, Sweden*

Bioaerosols make up a diverse set of particles that are essential for reproduction of organisms, can transmit diseases, and have been proposed as important agents in atmospheric processes. However, the abundance and temporal and spatial variability of bioaerosols remain to be understood. The aim of this study was to do continuous bioaerosol measurements and compare these to meteorological factors and bioaerosol concentrations derived from filter sampling. To our knowledge, this is one of the longest continuous ambient bioaerosol measurements and the first long-term bioaerosol study in Sweden.

We used a real-time viable particle counter (BioTrak, TSI Inc.) for continuous detection and sizing of fluorescent biological aerosol particles (FBAP) in the range 1-12 µm at the Hyltemossa Aerosols, Clouds, and Trace gases Research Infrastructure (ACTRIS) station in the south of Sweden for 18 months (October 2020 to April 2022). In parallel with real time FBAP counting, a PM_{10} filter sampler (Leckel SEQ47/50-RV) was operated. Each filter sampled 3-24 m^3 of air and 112 filters were stained with acid gel stain (SYBR Green I) for identification and counting of bioaerosols with fluorescence microscopy.

The FBAP number concentrations were dominated by particles in the size range 1-3 µm and were significantly higher in the summer, with an average FBAP number concentration of 0.020 cm^{-3}, compared to all other seasons ($P<0.0001$). Lower concentrations were measured with real-time counting than with the filter collection and staining method. The filter counts showed that particles in the size range 1-3 µm only contained a low number of single bacteria but were dominated by aggregates of bacteria and fungal spores. The FBAP number concentrations correlated with air temperature ($P<0.0001$), relative humidity ($P<0.01$) and wind speed ($P<0.05$).

2BA.4

Characterization of Aerosol in Poultry Farms with Low-Cost Sensors and Research-Grade Instruments.

Rowshon Afroz, Xinyang Guo, Chu-Wen Cheng, Sohaib Omar, Kerry Chen, Jason S. Olfert, Valerie Carney, Martin Zuidhof, RAN ZHAO, *University of Alberta*

The poultry industry contributes $8 billion to the Gross Domestic Product in Canada, where indoor farming dominates poultry production. Aerosol in indoor farms can be hundreds of times higher than those outdoors. With the current movement from caged to cage-free housings, aerosol concentrations are expected to rise further. At such high levels, aerosol and other air pollutants can induce a significant adverse health impact on both farmworkers and chickens. Aerosol concentration in farms is rarely monitored on a regular basis, largely due to the cost of aerosol instruments. The recent emergence of low-cost particle sensors has drastically changed the strategy of outdoor aerosol monitoring. The application of such sensors can potentially revolutionize environmental monitoring in poultry farms. However, the performance of low-cost sensors in poultry farms has not been evaluated before. The objectives of our study are to 1) characterize aerosol in egg farms using research-grade instruments and 2) evaluate the performance and accuracy of low-cost sensors in egg farms. Initial testing was performed at an experimental farm of Poultry Research Centre, University of Alberta. Advanced aerosol instruments, including an optical particle counter and an aerodynamic particle sizer, were used to monitor aerosol. Clogging of the inlet tubing was a serious issue for low-cost sensors, preventing their continuous operation on the farm. After changing the inlet design, the sensors operated continuously for weeks without maintenance. Initially, a large deviation was observed between the reading of low-cost sensors and research-grade ones. Utilizing gravimetric methods and aerosol instruments, we have deduced a calibration factor to correct the signal of low-cost sensors. In the near future, we are planning to apply our sensors and instruments to commercial table egg farms in the surrounding area.

2BA.5

Influence of UV Irradiation and Environmental Factors on the Size-Dependent Survivability of Bioaerosols. WEIXING HAO, Yang Wang, Yue-Wern Huang, *Missouri University of Science and Technology*

Indoor environments are ideal spaces for airborne transmission due to the favorable relative humidity (RH) and temperature levels, as well as the absence of ultraviolet germicidal irradiation (UVGI) light. These factors will affect the survival of indoor bioaerosol transport in various ways and to varying degrees, further complicating our understanding of the risks associated with indoor bioaerosols. Additionally, aerosol size is an essential factor in determining the survivability of indoor bioaerosols because it impacts the deposition pattern in the human respiratory system and the evolution of bioaerosols in an indoor environment. However, the size-dependent load and survivability of microorganisms under UVGI have not been studied in detail.

Here, we investigated the influence of UV irradiation intensity, temperature, relative humidity on the load and size-dependent survivability of two viruses (MS2 and Phi6) and two bacteria species (*Escherichia coli* and *Staphylococcus aureus*) bioaerosols in a temperature (10 to 60 ^{o}C), relative humidity (20 to 90%) and UV intensity (10 to 40 $\mu W/cm^2$) controlled small-scale laboratory test chamber. The aerosols were collected with a BioSampler, Sioutas cascade impactor, filter cassette containing gelatin filter. The results indicated that UV irradiation intensity, temperature and humidity are all significant factors of survivability. The survivability is inversely correlated with the UV intensity with a killing effect of 99% at 40 $\mu W/cm^2$. We demonstrated that bioaerosol size is a critical parameter influencing the load and survivability of microorganisms. Our understanding of the environmental factors can lead to an improved control of indoor infectious disease transmission.

2BA.6

What is the Best Cleaning Method the Public Can Use to Remove Bacillus Spores from Indoor Surfaces? JONATHAN THORNBURG, John Archer, Andrew Dart, Marshall Gray, M. Worth Calfee, *RTI International*

An outdoor, wide area release of a biological agent will significantly disrupt society. An unexplored aspect of consequence management and public health guidance is the need to minimize the risk from immediate and delayed exposure to Ba spores within the indoor environment. The possibility that “low technology” or “self-help” surface cleaning methods for the disinfection, removal, and resuspension of Ba spores with materials and chemicals readily available to the public could minimize risk requires research. We tested different combinations of cleaning materials, cleaning solutions, application methods, and cleaning force to cover a broad range of exposure and hazard risks. Experiments were conducted on laminate flooring loaded with dry Bacillus thuringiensis kurstaki (Btk) spores inside a sealed glove box. Spores resuspended, removed by the cleaning material, and remaining on the surface were extracted from the sample, plated, and incubated and counted. Comparison of spore resuspension, collection, and residuals within and between experimental conditions were inconclusive. We noted, however, that the spore counts on the cleaning material were 10 to 100 times higher than the number of spores resuspended or remaining on the surface. This observation led us to develop a risk minimization ratio, defined as the sum of the spores resuspended and remaining on the surface divided by the number collected by the cleaning material. This analysis determined a wet wipe with any type of cleaning liquid performed best, a paper towel with bleach or dry was in the middle, and a sponge dipped in bleach solution or dry was worst.

2BA.7

Antibiotic Resistance Genes in Air Near Farms. DAVID KORMOS, Gabriel Isaacman-VanWertz, Amy Pruden, Jactone Ogejo, Linsey Marr, *Virginia Tech*

The spread of antimicrobial resistance is considered one of the top 10 global health threats by the World Health Organization. To date most studies on antibiotic resistant genes (ARGs) have focused on water or soil, but ARGs in the air are concerning due to potential long-distance transport. To gain insight into sources of ARG emissions to the atmosphere, we have characterized ARGs in particles collected at two (swine and dairy) farms and wastewater treatment plants. We used a custom-built conditional sampler with a cascade impactor and a viable Andersen impactor to collect particles. At the swine farm, the concentrations of 16S rRNA, representing total bacteria, of ~107 gene copies per cubic meter of air (gc/m3). The number of gene copies decreased with decreasing particle size. Concentrations of the antibiotic resistance gene sul1 totaled ~103 gc/m3, with concentrations decreasing with particle size between 5 microns and 0.5 microns. A substantial amount of sul1 was associated with particles smaller than 0.5 microns, so it is likely part of extracellular DNA. The relative abundance (gene copies per 16S rRNA gene) of sul1 ranged between 7 x 10-5 and 1 x 10-3 gc/16S. We observed culturable E. Coli on all stages larger than 2 microns in the Andersen impactor. Additionally, we saw bacterial growth on all stages with CHROMagar Staph aureus. White, possibly mauve (maybe S. aureus), and light blue colonies appeared on the first three stages (3.3 microns and larger), only white and light blue colonies on the 4th and 5th stages (between 2.1 and 4.7 microns), and 6 white colonies and 1 dark blue colony on the final stage (smaller than 0.65 micron). No resistant bacteria were cultured from any stage of the sampler.

2BA.8

Seasonal Impacts on Microbiome Diversity and Antibiotic Resistance Patterns in Aerosolized Bacteria in a Dairy Facility. HYOUNGMOOK PAK, Maria King, *Texas A&M University*

The development and spread of antibiotic resistant bacteria (ARB) pose a serious threat to animal and human health. This is especially relevant to open-stall dairy farms where environmental factors play a significant role. This study identified the presence of ARB and their dissemination within a dairy farm over three seasons. The effects of temperature, relative humidity, and wind on bacterial diversity and antibiotic resistance in aerosol and manure samples were investigated. QIIME2 analysis showed that Firmicutes was the most abundant phylum (49%) followed by Proteobacteria (29 %), Actinobacteriota (17 %), and Bacteroidota (4 %) in all samples. Kirby-Bauer disk diffusion tests revealed that all manure samples were resistant to eight different antibiotics although antibiotics were not given to the cows. Winter aerosol samples was revealed to have the lowest microbiome diversity, but also the strongest antibiotic resistance. Antibiotic resistance mapping indicates that ARB were transported with the wind generated from axial fans and natural ventilation. Computational fluid dynamics (CFD) was utilized to examine the movement of bioaerosols within and around the dairy facility. CFD simulation results were compared with experimental results, such as air velocity measurements and microbiome data, to confirm and validate their accuracies. It was shown that low temperatures and wind correspond with increased antibiotic resistance and spread of ARB in the environment.

2BA.9

Agricultural Contributions to Fluorescent Bioaerosol Measured by the WIBS at the AGINSGP Campaign at the Southern Great Plains Site. DORIAN SCHWARTZ, Aleksandra Volkova, Gavin Cornwell, Isabelle Steinke, Susannah Burrows, J. Alex Huffman, *University of Denver*

Bioaerosol particles play important roles in a variety of atmospheric processes, with one such process being the formation of ice in the atmosphere due to their ability to act as ice nucleating particles (INPs). One type of instrument designed to detect and characterize bioaerosol particles is the Wideband Induced Bioaerosol Sensor (WIBS), which uses particle fluorescence as a proxy for the biological character of a particle. During the month of April 2022, a WIBS was brought to the US Department of Energy's Southern Great Plains site in Oklahoma to participate in the Agricultural Ice Nuclei at Southern Great Plains (AGINSGP) field data collection campaign. The campaign aimed to obtain a better understanding of agricultural contributions to INPs. Data showed relative fractions of fluorescent particles most frequently in the range of 5 – 40% of observed particle number, with initial evidence suggesting that the biggest fraction of fluorescent particles were contributed from the B and ABC categories. Preliminary results of fluorescent particle data will be presented and compared to other particle instruments with initial interpretations based on meteorology and local sources in the agricultural region.

2BA.10

Qualitative Analysis of Bioaerosol Chemical Composition and Shift by Means of 1HNMR. PALINA BAHDANOVICH, Kevin Axelrod, Andrey Khlystov, Vera Samburova, *Desert Research Institute*

The goal of this research is characterizing the chemical composition of bioaerosols using multiple analytical techniques, such as Proton Nuclear Magnetic Resonance (1HNMR), Fourier-Transform Infrared Spectroscopy (FTIR), UV-Vis Spectroscopy, Gas Chromatography-Mass Spectrometry (GC-MS), and Ultra-High Performance Liquid Chromatography-Mass Spectrometry (UPLC-MS), thereby advancing atmospheric aerosol chemistry. Various common bioaerosols, including pollen, algae, fungi, and bacteria, are analyzed and characterized under controlled laboratory conditions. This blueprint is also used for characterizing bioaerosols collected on ambient filter samples in Northern Nevada and California. All samples (laboratory-controlled and ambient) are analyzed for their chemical composition: saccharides and polar organic acids with GC-MS, amino acids with UPLC-MS, and functional groups with 1HNMR spectroscopy.

Assessment of the relative abundance of different functional groups is particularly useful in determining chemical nature (e.g., polarity) of analyzed bioaerosols. 1HNMR technique has been used for analysis of atmospheric aerosols, especially, for aerosols of anthropogenic origin. The present research is one of the first studies on detailed chemical characterization of bioaerosols with 1HNMR technique, where the 1HNMR results will be also compared with GC- and UPLC-MS quantitative analyses of individual bioaerosols organic species. Figure 1 shows the fractional distribution of major function groups identified in one of the 1HNMR spectra of a pollen extract (Pinus contorta) prepared in dimethyl sulfoxide-d6 (DMSO-d6). Analysis of 1HNMR spectra of pollen, fungi, algae, and bacteria bioaerosol extracts will be presented.

2BA.11

Optimization of a Wetted Wall Cyclone for Pathogen Collection. SOOHWAN KIM, Natacha Ramioulle, Ardalan Javadi, Mike Farrell, Alexander Alexeev, David Hu, *Georgia Tech*

One of the lessons COVID-19 left was the need for real-time monitoring of indoor air systems. Amongst different types of bioaerosol collectors, the Wetted Wall Cyclone (WWC) has a high flow rate and continuous particle collection in a hydrosol, which can be extracted and analyzed in real-time. In this computational and experimental study, we employed Computational Fluid Dynamics (CFD) approach to optimize fluid recovery and collection efficiency using changes in geometry and flow rates of hydrosol and air. OpenFOAM and COMSOL Multiphyiscs were used to simulate the multiphase flow of air and water and the collection of aerosols. Experimental results were compared with the numerical results to confirm improved performance.

2BA.12

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

Membrane filters are commonly used in air sampling. However, after collection on filters, viruses are vulnerable to being inactivated due to desiccation. Though gelatin filters can conserve virus viability, they sometimes disintegrate in longer-duration air sampling or at high temperatures. Thus, an alternative method is needed. This study explored whether increasing the hygroscopicity of a membrane filter by coating it with glycerol can improve the conservation of bacteriophage MS2 viability during air sampling.

In Phase 1 of the study, mixed cellulose ester (MCE) filters (0.8 µm pore size, 37 mm diameter) were assessed at the benchtop under two conditions: as-packaged and glycerol-coated, to determine whether the glycerol detrimentally impacted the viability of MS2. In Phase 2, MCE filters were used to collect aerosolized MS2 in three configurations: as-packaged, glycerol-coated, and wetted with 0.1X PBS. A gelatin filter was also used as a reference. Glycerol was coated onto as-packaged MCE filters by soaking them in 10% glycerol (v/v with Nanopure® water) and then baking them at 100 °C for 30 minutes. To prepare the PBS-wetted filter, 200 µl of 0.1X PBS was pipetted onto an as-packaged filter. Both benchtop and aerosol exposure periods lasted 30 minutes. A Collison nebulizer was used to aerosolize MS2 in Phase 2. Extraction of MS2 from filters was done into 0.1X PBS, followed by culturing on single-layer agar and quantification by the plaque assay.

The results from Phase 1 of the study showed 76% more recovery of viable MS2 from glycerol-coated filters than as-packaged. It indicated that glycerol has no detrimental effects on MS2 viability ($p=0.87$ by ANOVA). For Phase 2, the experimental setup has been validated by assessing sampling ports and pumps and the aerosol collection trials are ongoing. The complete study will be presented at the conference.

2BA.13

Impact of Chemically Reductive Trace Air Contaminants on Non-thermal Plasma Inactivation of Airborne Viruses.

Zhenyu Ma, Kenneth Chung, HEREK L. CLACK, *University of Michigan*

Our previous work demonstrated the effectiveness of non-thermal plasmas in neutralizing airborne viruses with specific focus on animal agriculture. Clearly, since 2019, there has been increased focus on the need for such technologies in human-occupied spaces as well. In both human and animal applications, ambient air can contain trace amounts of chemical air pollutants; in animal agriculture, ammonia and hydrogen sulfide dominate. We have experimentally investigated the effect of trace chemically reducing air pollutants on the performance of a plasma reactor to inactivate bacteriophage MS2 aerosols by conducting plaque assays on collected aerosols upstream and downstream of the plasma reactor. Inactivation results are reported after subtracting aerosol filtration through the reactor. Results show that the introduction of 1 ppm of NH_3 in air slightly decreased the inactivation efficiency, but to a degree that was not statistically significant. Introduction of 1 ppm of H_2S and NO had more profound inhibitory effects on plasma inactivation. For NH_3 and H_2S, these results suggest that plasma air sterilization could retain its effectiveness in treating outside air drawn into animal confinement buildings, but could be hindered in treating air inside such buildings where concentrations of these compounds is substantially higher than 1pmm.

2BC.1

Developing and Testing Low-Cost Air Cleaners for Safer Spaces during Wildfires.

BRETT STINSON, Aurelie Laguerre, Elliott Gall, *Portland State University*

Air cleaning can reduce indoor exposure to fine particulate matter ($PM_{2.5}$) during wildfire events. However, resource and cost restraints may limit access to air cleaning during such an event, as both commercial devices and high-rated MERV filters that homemade assemblies typically rely upon may be cost-prohibitive and/or in short supply. With these barriers in mind, we sought to develop an air cleaner that utilizes common household fabrics that can be affixed to a box fan. We experimentally determined the clean air delivery rate (CADR) of the prototyped device with five fabrics attached (cotton batting, polyester, felt, flannel, and chiffon), and for comparison, tested two popular, homemade air cleaning configurations with and without flowrate-increasing shrouds, namely a single MERV 13 filter attached to a box fan and the Corsi-Rosenthal box. We employed the pressure-matching method in a 3-meter section of well-sealed ducting, directly measuring the air flowrate at three fan speeds through the device. We then measured the single-pass removal efficiency of the five selected fabric and MERV 13 filters via an apparatus that pulled air through a series of in-line particle counters, challenging filters with two distinct smoke sources: smoldering combustion of a powdered wood product and a smoke proxy from a commercially available smoke detector test aerosol. Preliminary field testing of a full-scale prototype using a simple cotton batting filter show $PM_{2.5}$ CADR > 100 cfm is achievable; these field tests results are generally consistent with CADRs calculated from laboratory testing of airflow and removal efficiency.

2BC.4

Environmental Factors Governing Pre-ignition Release of Organic Matter in Combustion of Large Wood Samples.

JOHN FLYNN, Tami Bond, *Colorado State University*

Biofuel burning emissions are most active early in the pyrolysis phase before ignition occurs. During this pre-ignition stage in large form-factor samples (~ 10^2 cm^3), unburned hydrocarbons are released in the form of organic aerosol and heavy and light molecular weight gases, leaving behind a char layer. Through thermal decomposition, mass is transferred from the solid phase into the gaseous region outside the char layer where combustion can occur. These releases vary with time, so that the occurrence of ignition during cellulosic biomass combustion is difficult to predict. After ignition, flames consume unburned fuel and emissions of this organic matter decrease. This pre-ignition phase can produce half of the particulate mass emissions in poor combustion. Therefore, understanding the system's behavior prior to ignition can provide insight about the conditions that release large quantities of particulate matter, giving guidance for burning design under these high-emitting conditions.

In order to explore the potential for rapid ignition and stable biomass combustion, a deeper understanding of what forces drive the gas and particle phase ejection from pyrolyzing wood is needed. It has been shown that pyrolysis and the release of combustible fuel is a repeatable and deterministic process. [Fawaz, et al., 2021] Environmental factors influencing the rate of mass loss during the short period of pre-ignition pyrolysis are reported here. We summarize pre-ignition mass loss rate, ratios of CO and CO_2, particle size distributions, and emission factors in the early stages of material ejection during pyrolysis. Critical flux conditions that can lead to ignition are identified and contrasted between the two-dimensional system of biofuel combustion and guidance for the one-dimensional systems in fire safety literature.

2BC.5

Characterization of Biomass Burning Influence in Houston and El Paso, TX Utilizing Aerosol Optical Properties and Offline Filter Analysis.

MACKENZIE GRAHAM, Manisha Mehra, Subin Yoon, James Flynn, Rebecca J. Sheesley, Sascha Usenko, *Baylor University*

Biomass burning (BB) releases large quantities of fine particulate matter and gas- phase pollutants, which can undergo long-range transport and negatively influence urban air quality. To address this problem, the Black and Brown Carbon aerosol optical study $(BC)^2$, in its fourth year of development, utilizes a combination of real-time aerosol optical measurements, offline filter analysis, back trajectories, and NOAA HMS smoke product at multiple urban sites in Houston and El Paso, TX. The $(BC)^2$ sites are equipped with two tricolor absorption photometers (TAP), a three-wavelength nephelometer, and an automated high-volume filter sampler. The TAPs and nephelometer measure absorption and scattering coefficients that are used to calculate intensive aerosol optical properties: Absorption and Scattering Ångström Exponents (AAE and SAE), which are used to identify periods of BB influence for a site with high time resolution. The high resolution of the dataset allowed us to look at time-of-day as well as long-term trends with relation to other meteorological conditions. The events identified by the optical measurements were explored further for trends in time-of-day to investigate how variation in boundary layer height and vertical mixing contributes to BB signal at ground-level. Understanding the factors that contribute to BB influence in urban areas can help us better characterize the seasonality of such events. Results from the $(BC)^2$ 2021 field campaign, March through October, will be presented.

2BC.6

PM2.5 and BC Characteristics in the Sao Paulo Megacity, Southeastern Brazil. CAROLINE FERNANDA HEI WIKUATS, Rafaela Squizzato, Thiago Nogueira, Edmilson Dias de Freitas, Maria de Fatima Andrade, *University of São Paulo*

$PM_{2.5}$ concentrations are still above the Air Quality Standards in the Metropolitan Area of São Paulo (MASP), the fourth-largest urban agglomeration in the world with 21.6 million inhabitants and the most developed and industrialized region in South America. Many studies have been performed in São Paulo but without evaluating the toxicity of $PM_{2.5}$ associated with its sources. Therefore, we intend to determine the chemical composition, emission sources, and toxicity of $PM_{2.5}$ with measurements in an urban site close to vehicular emissions. $PM_{2.5}$ and BC samplings in the Faculty of Medicine of the University of São Paulo (FMUSP) occurred from May 10 to October 31, 2021. Average concentrations of $PM_{2.5}$ in PTFE filters and the TEOM monitor were 16.3±9.6 and 14.7±8.9 $\mu g.m^{-3}$, respectively. For BC evaluated with the Aethalometer, the result was 1.6±1.5 $\mu g.m^{-3}$. August 23 to 25, 2021, presented the highest daily concentrations related to biomass burning in a state park at MASP, as northwesterly winds transported the smoke plume to FMUSP. $PM_{2.5}$ values ranged from 38.9 to 42.2 $\mu g.m^{-3}$ in PTFE filters, 38.7 to 43.3 $\mu g.m^{-3}$ in the TEOM monitor, and 3.5 to 5.0 $\mu g.m^{-3}$ for BC. Wildfires are a significant event in some Brazilian regions in winter, mostly between August and September. In August 2021, 2,277 fire outbreaks followed in the state of São Paulo, an increase of 282% compared to July. During the analyzed period, the major elements observed in $PM_{2.5}$ samples were sulfur, sodium, potassium, iron, silicon, zinc, and aluminum, with values ranging from 946.0 to 127.7 $ng.m^{-3}$. These elements are mainly related to vehicular emission, brake and tire wear, and soil resuspension, which are characteristics of the sampling site since FMUSP is close to high-traffic roads. Sources quantification will be assessed by applying the Positive Matrix Factorization (PMF).

2BC.7

Identification of Individual Residential Wood Burning Aerosols and Secondary Aerosol Formation during Wintertime Fairbanks, Alaska. ANDREW HOLEN, Judy Wu, Ellis Robinson, Karolina Cysneiros de Carvalho, Damien Ketcherside, Vanessa Selimovic, William Simpson, Lu Hu, Brent Williams, Peter F. DeCarlo, Kerri Pratt, *University of Michigan*

Severe wintertime air pollution, particularly in high latitude cities, is understudied and gaining significant attention due to adverse human health effects. Specifically, Fairbanks, Alaska experiences some of the highest $PM_{2.5}$ (particulate matter < 2.5 µm) levels in the United States largely due to a combination of increased heating needs and strong wintertime atmospheric inversions that trap pollutants near the ground. Previous measurements show that organic carbon and sulfate dominate $PM_{2.5}$ during pollution events, but uncertainties surround the contributing sources, including a variety of residential heating methods. Therefore, the Alaskan Layered Pollution and Chemical Analysis (ALPACA) field campaign was conducted in Fairbanks, AK, from Jan. 17 – Feb. 26, 2022. Here, we focus on measurements made using an aerosol time-of-flight mass spectrometer (ATOFMS), which provided individual aerosol particle size, chemical composition, and mixing state in real-time. Individual particle mass spectra provide a "chemical fingerprint" of the primary particle source and any secondary aerosol formation. Simultaneous aerosol size distribution measurements were also conducted. Together these methods provide quantitative identification of individual aerosol sources. In particular, we evaluate domestic heating (oil, wood, coal) and local power generation (coal and oil) as sources of combustion aerosol. In addition, we examine the internal mixing state of secondary aerosol species with biomass burning aerosols. These results improve the understanding of wintertime aerosol chemical composition, sources, and processes.

2BC.8

Environmentally Persistent Free Radicals, Reactive Oxygen Species and Oxidative Potential of Particulate Matter: A Case Study in Fairbanks, Alaska. SUKRITI KAPUR, Kasey Edwards, Ting Fang, Manabu Shiraiwa, *University of California, Irvine*

The Alaska Layered Pollution And Chemical Analysis (ALPACA) campaign was held in January-February 2022 to understand wintertime pollution in cold and dark environments in Fairbanks, Alaska. As a part of this campaign, we conducted indoor and outdoor particle collection to study Environmentally Persistent Free Radicals (EPFRs) and Reactive Oxygen Species (ROS) production. EPFRs are long-lived species and have the ability to form ROS such as hydroxide (•OH), superoxide (O2•−), hydroperoxyl radical (HO2•), and hydrogen peroxide (H2O2). ROS are known to cause adverse impacts on human health by causing oxidative stress. We used a Tisch High-Volume sampler to collect ambient particulate matter with aerodynamic diameters less than 2.5 um (PM2.5), and a Micro-Orifice Uniform Deposition Impactor (MOUDI) to collect size-segregated particles (0.056-18 um) at a residential home where typical indoor activities such as cooking and pellet stove burning were performed. Indoor and outdoor samples were analyzed for EPFRs and ROS using an Electron Paramagnetic Resonance (EPR) Spectrometry. Oxidative potential, defined as the ability of PM to generate ROS, was quantified using the dithiothreitol (DTT) assay. Highest EPFR signal has been observed for stages with lower cutoff diameters, with concentrations ranging from 0.21± 0.11 pmol/ug for mixed (cooking & pellet stove burn) experiments, to 0.77± 0.56 pmol/ug for pellet stove burning experiments. The presence of •OH radical has been detected in the analysis for ROS. These findings will serve in a better understanding of indoor air pollution and its impacts on human health and in filling critical knowledge gaps about outdoor chemistry in sub-arctic regions.

2BC.9

Particle Number and Size of Emissions during Realistic Operation of Two Residential Cordwood-Fired Hydronic Heaters. JAKE LINDBERG, Rebecca Trojanowski, Nicole Vitillo, Marilyn Wurth, Shida Tang, Gil H. LaDuke, Brian P. Frank, Patricia Fritz, Thomas Butcher, Devinder Mahajan, *Brookhaven National Labs*

Operation and use of outdoor wood-fired hydronic heaters can pose a concern from an environmental health and safety as inefficient combustion of solid fuels, such as cordwood, can result in production of pollutant emissions. Wood-fired hydronic heaters are particularly concerning as they tend to have large combustion chambers and typical use patterns can result in long periods of low output, which result in sustained periods of high particle concentration aerosol emission.

In this study, we describe the particle number concentration and particle size distribution of the flue-gas aerosol emitted from two residential cordwood hydronic heaters over a wide range of operating conditions, such as cold-starts, warm-starts, four different levels of output ranging from 15% to 100% maximum rated output, and periods of repeated cycling. Measurements of flue gas particulate number concentration and size for particles with aerodynamic diameters between 0.006 and 10 micrometers were made using a dilution sampling system. The measured particle number concentration in the flue gas was between 0.71 and 420 million particles per cubic centimeter. The majority of the particles had aerodynamic diameters less than 0.100 micrometers (particles of this size made up between 64% and 97% of all particles) and less than 1% of all particles had aerodynamic diameters greater than 1 micrometer. The particle number concentration and the particle size in the accumulation mode, between 0.100 and 1 µm, was dependent on fuel loading and heat output.

2BC.10

On the Image Processing Methods for Morphological Characterization of Biomass Smoke Particles. HAMED NIKOOKAR, Timothy Sipkens, Steven Rogak, *University of British Columbia*

Image processing methods have found wide use in interpretation of microscopic micro/nanoscale data. For the special case of soot, they are implemented in conjunction with Transmission Electron Microscopy (TEM) to study different morphological properties such as aggregate equivalent size, primary particle size, number of primaries, and fractal properties. Recently, the fast automated image segmentation and primary particle detection algorithms have replaced the time and effort taking user-adjusted analyses in the study of soot. The automated approaches include both the more classic methods that involve filtering, transformation, and morphological operations calibrated for certain applications, and the newer unsupervised and supervised machine learning methods that self-tune the operations discussed. While the previous studies showed that these methods are more or less robust for fresh soot, they have not been explored so much for the scenarios where the emissions age in the ambient air and produce quite diverse particle populations. In this study, we investigated an example of such cases where the brown haze images from a forest fire near Kamloops, BC in July 2021 were examined using a recently developed machine learning method that implements *k*-means clustering to decide on the segmentation of particles from their backgrounds and prepares them for further higher-level analyses. The segregated particles are evaluated by their size and three other less-studied parameters, i.e., circularity, optical depth, and acutance- that account for the shape and radiative properties. Results based on *k*-means are compared with the manual ones to assess the performance of this state-of-the-art method for more complex particle populations. It is shown that *k*-means interestingly performs well enough to capture particle boundaries and well predicts the second-hand morphological distributions. Discrepancies, however, also appear from the manual data especially for the cases where the effect of aging is more dominant.

2BC.11

Chemical Characteristics of Aerosol Particles and Surface Films during the CASA Field Campaign. CHURCHILL WILKINSON, Delphine K. Farmer, Marina Vance, Dustin Poppendieck, Rachel O'Brien, *University of Michigan*

Indoor surfaces play important roles in indoor air quality due to the high surface area to volume ratios in our homes. These films are formed from the deposition of aerosol particles and the sorption of semi-volatile organic compounds and are thus often complex mixtures of organic chemicals. The chemical complexity can expand even further after film formation as the chemicals in the mixture react and age on the surface. The composition of these films will play a role in their behavior indoors, so an improved understanding of the important chemical classes found in these films will help model predictions for partitioning of organic chemicals in indoor air. One important source for chemicals in these films in some areas is aerosol particles from wildfires. Depending on the distance of the building from the fire, these biomass burning organic aerosol particles (BBOA) can reach indoor spaces at different levels of aging. Here, we investigate the chemical composition of size resolved aerosol particles from representative wood smoldering that was injected into the NIST test house during the CASA field campaign. We compare this composition to the surface films found on glass surfaces deployed during these same events.

2BC.12

Fine Particulate Matter Sources Identification through PMF-Hysplit Modeling Based on Metals and Carbonaceous Compounds. RAFAELA SQUIZZATO, Caroline Fernanda Hei Wikuats, Thiago Nogueira, Edmilson Dias de Freitas, Maria de Fatima Andrade, *University of São Paulo*

In South America, few studies involve the chemical composition of fine particulate matter ($PM_{2.5}$), especially in cities with less than 300,000 inhabitants, where live about 23 % of the world's population. In Brazil, those cities can have their air quality impacted by local and distant sources of air pollution. The lack of studies in these areas limits possible actions that aim to improve the control of atmospheric emissions. The present study was carried out in the southeastern region of Brazil, from June 12 to August 25 of 2019 (dry season), an area of frequent fires due to the planting of sugarcane for ethanol production (biofuel) and long-range transport of forest fires. Daily data on the elemental composition of $PM_{2.5}$ and carbonaceous compounds (OC, EC, and BCe) were considered for the identification of profiles and source contributions by applying the Positive Matrix Factorization (PMF) model. The main sources were soil/dust resuspension, biomass burning, and vehicular (light and heavy vehicles) emissions. The Hysplit trajectory model showed that the highest concentrations of particulate occurred when the trajectories were from the North, although the predominance of winds in the site was from the southeast. Preliminary results show that $PM_{2.5}$ concentrations were relatively low (average 9 ± 4 µg m^{-3}) during the sampled period. Still, unstable atmospheric conditions may have contributed to the dispersion of pollutants, altering the air quality at the station. During the sampling period, pollution plumes were detected from burning areas in Central and North Brazil and from the Metropolitan Region of São Paulo (RMSP), located 200 km away from the sampling site in the East/Southeast direction.

2BC.13

Determination of Polycyclic Aromatic Hydrocarbons from Wildfire Smoke on Indoor Surfaces. Aurelie Laguerre, Brett Stinson, ELLIOTT GALL, *Portland State University*

Wildfire events are occurring with increasing frequency, impacting both outdoor and indoor air quality. Wildfires are a substantial source of polycyclic aromatic hydrocarbons (PAHs), a class of compounds with adverse health impacts. Indoor surfaces may accumulate PAHs during an wildfire event, potentially contributing to longer-term PAH exposures post-wildfire. To understand the abundance, retention and chemistry of PAHs on interior indoor surfaces (glass, drywall), a sampling and extraction method is developed using solvent-soaked wipes followed by sonication and gas chromatography – mass spectrometry analysis. We modified the method to recover PAHs from HVAC filters by directly extracting a section of a filter (i.e. no solvent wipe). Total and extraction recovery rates were estimated by doping the surfaces with a known quantity of a mixture of 16 PAHs. Extraction recovery rates ranged from 7 to 86 %. Total recovery rates, that include sampling and extraction processes, ranged from 0.1 to 77 % for glass, and from 0.7 to 37 % for painted drywall. Across tested materials, we observed low recovery rates for low molecular weight PAHs and higher recoveries for high molecular weight PAHs. Recovery rates were consistently low for painted drywall, suggesting PAHs are retained, perhaps due to the porosity of the paint. In contrast, we find consistently higher recoveries from HVAC filters, another porous material, likely due to sonication of the material without need for solvent wipe. Ongoing studies will expose materials to simulated woodsmoke and estimate retention of PAHs under natural attention and various cleaning conditions.

2BC.14

Collection and Characterization of Wildfire Smoke Particulate using Automated SEM Techniques. Roger West, Traci Lersch, GARY CASUCCIO, *RJ Lee Group, Inc.*

Conditions related to global warming have resulted in more frequent and intense wildfires in the western United States. Emissions generated during wildfires affect ambient air quality with smoke aerosols primarily concentrated in fine particulate matter. Studies incorporating automated scanning electron microscopy (SEM) methods have been performed to characterize emissions from wildfires and evaluate their contribution to ambient air quality. In these studies, a passive sampler developed at the University of North Carolina (UNC) was deployed to collect particles in wildfire environments. The passive samples were analyzed using automated SEM techniques to provide information on particle mass and species concentrations associated with ambient concentrations of PM10 and PM2.5. SEM imaging and elemental composition were applied to identify emissions known to be associated with wildfire emissions.

2BC.15

Increased Levels of Atmospheric Phosphorus and Other Nutrients Associated with Fires in the Western United States. NICOLE OLSON, Katie Boaggio, R Byron Rice, Stephen LeDuc, Uma Shankar, *U.S. EPA*

Wildfire activity is increasing and linked to climate change effects including rising global temperatures and more frequent drought conditions. Wildfire emissions likely impact human health and sensitive ecosystems, particularly in the western United States where fire frequency and severity have increased dramatically in the past decade. Herein, 15 years (2006-2020) of PM2.5 chemical speciation data were linked with smoke plume analysis to identify airborne nutrients that were elevated on smoke-impacted days. Except for ammonium, all macro- and micro-nutrients analyzed (phosphorus, calcium, potassium, sodium, silicon, copper, aluminum, iron, manganese, magnesium, zinc, nitrate) were elevated on fire days, with some nutrients episodically elevated >10,000% during select fire events. A box model was developed to calculate phosphorus deposition from atmospheric concentrations on smoke days, facilitating a comparison to other fluxes of phosphorus. Air mass trajectory analysis and satellite cyanobacteria measurements suggest fire emissions influence algal activity in lakes up to 65 kilometers downwind from fires. These results suggest potential implications for the emergence of harmful algal blooms, even in alpine lakes with limited upstream agriculture and nutrient inputs.

The views expressed in this presentation are those of the author(s) and do not necessarily represent the views or policies of the Environmental Protection Agency.

2BC.16

The Influence of Black Carbon Aerosols from Prescribed Fires on Regional Air Quality in the Southeast US.

DONGLI WANG, Ren Garity, Andrew Metcalf, *Clemson University*

Although typically not as newsworthy as Western US wildfires, biomass burning from prescribed and wild fires impacts the southeastern US to a large degree as well. While prescribed fires help restore and maintain the ecosystem, emissions from prescribed fires lead to air quality degradation. Black carbon (BC) refers to one of the important aerosol emissions from open biomass burning, affecting air quality and human health on regional scale. BC is also an efficient light-absorbing aerosol component in the atmosphere. Optical properties are critical parameters determining the impacts of aerosol emissions on climate and are highly dependent on aerosol composition.

This talk will discuss BC characteristics and aerosol properties at ground level from prescribed fires in the southeastern US, specifically in the Clemson Experimental Forest (CEF) in South Carolina. A Single Particle Soot Photometer (SP2) is employed as the primary measurement of BC aerosol and its number and mass mixing ratios, BC mass and size distributions, and number fractions of coated and uncoated BC aerosol particles. Detailed analysis of SP2 data will be used to determine the mixing state of BC aerosol. A scanning mobility particle sizer (SMPS) is used to measure the total submicron aerosol size distributions. A comprehensive investigation of BC aerosol emissions in context with total aerosol helps complete an emission inventory, predict possible harm to humans and the environment, and predict aerosol optical properties from its composition. The impact of prescribed fires in the CEF on local and regional communities will be assessed.

2BC.17

Chemical Characterization of Particulate Organic Nitrogen Compounds Produced from Prescribed Burns of Managed and Unmanaged Western U.S. Forests.

FARRAH HAERI, Daniel Foster, Deep Sengupta, Afsara Tasnia, Paul Van Rooy, Nathan Kreisberg, Lindsay Hatch, Christos Stamatis, Scott Stephens, John Battles, Robert York, Kelley Barsanti, Allen Goldstein, Coty Jen, *Carnegie Mellon University*

A significant source of organic nitrogen (ON) compounds in the atmosphere are emitted from biomass burning (BB) events, including wildfires and prescribed burns. ON compounds absorb light, contributing to a warming climate, or deposit onto land and oceans resulting in disruptions of the nitrogen cycle. However, the implications of prescribed burning emissions on air quality or environment are not well characterized, especially regarding the ON contribution from prescribed burning emissions. For this study, we chemically characterize and quantify emission factors (EF) of ON compounds from freshly emitted smoke PM 2.5 particles. Smoke particles were collected via Sequential Spot Sampler during prescribed burns of an unmanaged forest in 2021 and quartz fiber filters from third-entry managed forest plots in 2017 at Blodgett Forest Research Station (BFRS, Georgetown, CA) using a high-performance liquid chromatographers (HPLC) coupled to an orbitrap mass spectrometer. This study differentiates smoke from prescribed burns in managed and unmanaged forest plots based on molecular speciation of hundreds ON compounds as well as quantify the compounds' respective mass concentrations and EF. We observe that EF of various groups of ON compounds (e.g., CHNO, CHNOS, CHN) are 2-3x higher in unmanaged than managed forests. Results from this non-targeted analysis show that ON emissions in prescribed burning contribute 30-40% by mass of observed speciated smoke emissions, with CHNO and CHNOS compounds dominating that composition. Our observations will help better inform the effects ON compounds from prescribed burns of managed and unmanaged forests have on the atmosphere and climate.

2BC.18

Chemical Composition of Individual Indoor Aerosols in Fairbanks, Alaska. LOGAN FORSHEE, Andrew Holen, Judy Wu, Ellis Robinson, Damien Ketcherside, Vanessa Selimovic, Sukriti Kapur, Karolina Cysneiros de Carvalho, William Simpson, Lu Hu, Brent Williams, Peter F. DeCarlo, Kerri Pratt, *University of Michigan*

The effects of outdoor air pollution on the human body, including cardiovascular and respiratory complications, is well-documented. Recently, more attention has been brought to concerns about indoor air quality and our knowledge gaps in this field. Indoor air quality is important as humans in developed countries spend a majority of their time indoors, especially in colder climates such as the subarctic. During the Alaskan Layered Pollution and Chemical Analysis (ALPACA) field campaign in Fairbanks, Alaska conducted from January to February 2022, indoor air quality was investigated through detailed chemical characterization of indoor aerosols. Using an aerosol time-of-flight mass spectrometer (ATOFMS), the real-time size and chemical composition of individual aerosol particles were measured. Additionally, a scanning mobility particle sizer (SMPS) and an aerodynamic particle sizer (APS) measured aerosol size distributions. The chemical composition of indoor aerosols, including those resulting from indoor cooking, pellet stove, and incense burning experiments, were explored in this work. From this data, we will better be able to understand the sources and chemical composition of individual indoor aerosols.

2BC.19

Evaluation of Low-cost Aerosol and Gas Sensors for Real-time Measurements of Electronic Cigarette Exposure. SINAN SOUSAN, Dillon Streuber, Yoo Min Park, Vivien Coombs, Jack Pender, Eric Soule, *Department of Public Health, East Carolina University*

Indoor electronic cigarette (ECIG) use exposes bystanders to airborne $PM_{2.5}$ (particulate matter 2.5 µm and smaller) and volatile organic compounds (VOCs). To understand potential risks for bystanders, it is important to accurately measure real-time ECIG exposure. However, there is no study that evaluates the performance of low-cost sensors for real-time measurements of indoor ECIG aerosol concentrations. Thirty-two low-cost GeoAir2 monitors were used to detect ECIG-generated $PM_{2.5}$ and VOCs inside a controlled laboratory exposure chamber. The GeoAir2 was compared to an OPC-N3 low-cost monitor and the MiniWRAS and MiniRae reference instruments. Three ECIG devices (JUUL, NJOY Daily, and VOOPOO DRAG 2) were used to generate emissions using a pump programmed to puff based on ECIG-user puffing behaviors. The GeoAir2-measured $PM_{2.5}$ concentrations were similar to the raw MiniWRAS-measured concentrations data were close or on the 1-1 line for the JUUL, on the 1-1 line for concentrations lower than 200 µg/m3 for the NJOY Daily and overestimated for the VOOPOO DRAG 2 (mean correlation ≥ 0.97). The OPC-N3 significantly underestimated concentrations compared to the raw and filter-corrected MiniWRAS concentrations (mean correlation ≥ 0.98). The GeoAir2 VOC concentrations compared to the MiniRae were on the 1-1 line for the VOOPOO DRAG 2, overestimated for the JUUL and NJOY Daily (mean correlation ≥ 0.98). These results show that GeoAir2 is an effective tool for examining ECIG use in indoor settings, such as homes, vehicles, workplaces, vape shops, or other locations, to better understand bystander exposures to ECIG aerosol.

2BC.20

Understanding the contributions of different types of biomass combustion to ambient PM2.5 and ozone in the United States using CMAQv5.3.3. JIAOYAN HUANG, Shih-Ying Chang, ShinMing Huang, Frederick Lurmann, *Sonoma Technology Inc.*

In this study, we investigated the contributions of different types of biomass combustion emissions on human exposure to fine particulate matter ($PM_{2.5}$) and ozone (O_3) concentration in California in 2018, one of the top years for fire activity. Using the emissions inventories developed in this study and by the U.S. Environmental Protection Agency (EPA), we applied the Community Multiscale Air Quality (CAMQ) model and a brute force (BF) method to investigate the contribution of $PM_{2.5}$ and O_3 emissions from wildfires (WF), prescribed fires (Rx), agricultural fires (AG), and residential wood combustion (RWC) in the U.S. and, more specifically, California.

Non-biomass emissions, AG fires emissions, meteorological data, and boundary/initial conditions were developed and provided by the EPA from their previous studies on WF contributions to air pollution. CMAQ was run without implementing potential secondary organic aerosol from combustion emissions (PcSOA) for these biomass emission sectors as suggested by CMAQ release notes. The performance of the resulting CMAQ simulation was reasonable, and the normalized mean bias for total $PM_{2.5}$ and O_3 emissions ranges from 30-35% and 0-15%, respectively.
WF is the most important emission source of $PM_{2.5}$ from July-September in California, with monthly average contributions ranging from 50-75%. WF is also the most important biomass emission sector on a national scale, at 25-50%. The second largest contributor of $PM_{2.5}$ is Rx emissions (monthly contribution from >5-25%); however, the variations of Rx $PM_{2.5}$ contributions from October-April were higher nationally than in California. RWC can contribute up to 15% of monthly averaged $PM_{2.5}$ emissions in California and nationally. Detailed seasonal and spatial variations of biomass burning contributions and chemical composition of $PM_{2.5}$ will be discussed and presented. The results of the study will be used for understanding the relationship between (1) biomass burning smoke exposures during pregnancy, and (2) preterm births in California.

2BC.21

Cooking Stove Emission Transmission in the Rural Environment. YUCHENG HE, Sanika Nishandar, Marko Princevac, Rufus Edwards, *University of California, Riverside*

Open fire stove emitted particulate matter (PM) is one of the major contributors to the ambient pollution in the rural area, where the residential energy demand is intense. This study intends to quantify the contribution of the stove combustion emissions to the outdoor neighborhood particulate matter (PM2.5) concentration. This study deployed Quick Urban & Industrial Complex (QUIC) and AERMOD to predict the fate of aerosols upon release to the outdoor environment, especially the distribution in a building wake. The study region is divided by different house packing densities to analyze the impact of building configuration on the pollutant trapping rate. In addition, the sources of emissions are categorized as local and upstream neighborhood sources. The results demonstrated that upstream households contributed ~30% of pollution concentration to the downwind neighborhood. The pollutants in the vicinity of houses tend to infiltrate back into the houses and worsen the indoor air quality. The QUIC model stands out due to its ability to capture the PM distribution in the proximity of buildings. The flow patterns that develop around buildings are evaluated. Interventions, such as the implementation of cleaner stoves and cleaner fuels, to improve local air quality are proposed and analyzed in the study. In this presentation, we will discuss factors including emission rates, modeling methods, meteorological conditions, and household configurations that are influential to aerosol dispersion.

2BC.22

Relative Contribution to Light Absorption by Methanol-soluble and Methanol-insoluble Brown Carbon Emitted from Biomass Burning. Khairallah Atwi, Zezhen Cheng, Omar El Hajj, Charles Perrie, RAWAD SALEH, *University of Georgia*

Methanol is often used to extract biomass-burning aerosol emissions in order to retrieve brown carbon (BrC) light-absorption properties. However, recent studies have reported that methanol-extraction leads to underestimating BrC absorption due to the existence of BrC that is insoluble in methanol. Here, we produced carbonaceous aerosol particles from the combustion of three biomass fuels (pine needles, hickory twigs, and oak foliage) in an environmental chamber. We performed a combination of online and offline measurements and optical calculations to estimate the mass fractions and contribution to light absorption by methanol-soluble BrC (MSBrC), methanol-insoluble BrC (MIBrC), and elemental carbon (EC). Averaged over all experiments, MSBrC accounted for 90% ± 5% of the carbonaceous aerosol species, while MIBrC and EC accounted for 9% ± 5% and 1% ± 0.5%, respectively. The BrC produced in all experiments was categorized as moderately absorbing BrC, with an imaginary part of the refractive index (k) at 532 nm ranging between 0.01 and 0.05. However, k at 532 nm of MIBrC (0.211 ± 0.113) was two orders of magnitude larger than that of MSBrC (0.004 ± 0.002), with MSBrC categorized as weakly absorbing BrC and MIBrC as strongly absorbing BrC. Consequently, even though MSBrC dominated the aerosol mass (90% ± 5%), MIBrC dominated light absorption at 532 nm (72% ± 11%). The findings presented in this poster provide support for previous studies that reported the existence of strongly absorbing BrC species that are insoluble in organic solvents. Furthermore, our results indicate that relying on methanol extraction to characterize BrC in biomass-burning emissions would severely underestimate its absorption.

2CC.1

Cloud Condensation Nuclei Activity and Hygroscopicity of Fresh Biomass Burning Particles as a Function of Burning Conditions. MEGAN MOUTON, MarkieSha James, Kotiba A. Malek, Rudra Pokhrel, Marc Fiddler, Akua Asa-Awuku, Solomon Bililign, *North Carolina A&T State University*

The hygroscopic growth of aerosol particles is of current interest due to their effects on light scattering and absorption properties of particles which thereby affect the air quality, visibility, Earth’s radiation, and the climate. Knowledge of hygroscopic properties is essential to prediction of the role of aerosol in cloud formation, regional visibility, and lung deposition.

In this work we measure and report aerosol hygroscopicity with different instrumental techniques and metrics. A widely used parameter is the aerosol particle size hygroscopic growth factor (GF) and is the ratio of the wet particle diameter (Dp,wet) at a high relative humidity (RH) to the corresponding dry diameter (Dp,dry). The aerosol optical hygroscopic enhancement factor (f(RH)) is defined as the ratio of aerosol optical properties (aerosol extinction, scattering, or backscattering coefficients) between wet and dry conditions and is also measured and reported. Most of the studies reported used surrogate components of complex aerosols. The application to complex multi-component aerosols like biomass burning aerosols is limited.

We report aerosol hygroscopicity parameter of biomass burning aerosols derived from African biomass fuels using a humidified smog chamber into ways: Measuring extinction hygroscopic enhancement factor f(RH) for dry and wet aerosols using a cavity ring down spectrometer and deriving the hygroscopicity parameter, and directly using a Cloud Condensation Nuclei Counter (CCNC). These measurements were also made at different burning conditions representing various burning stages ranging from smoldering dominated to flaming dominated burning conditions. Results indicate that the aerosol hygroscopicity is fuel and combustion condition dependent and that the measurement and subsaturated and supersaturated conditions show an evolving aerosol hygroscopicity.

2CC.2

Sensitivity Analysis of Brown Carbon on Snow Albedo Using SNICAR Radiative Transfer Model. GANESH CHELLUBOYINA, Chenchong Zhang, Rajan K. Chakrabarty, *Washington University in St. Louis*

Deposition of light absorbing particles (LAPs) on snow induces a reduced surface albedo compared to that of pristine snow. Brown carbon (BrC), in contrast to other LAPs, strongly absorbs solar radiation in the ultraviolet (UV) and short visible wavelengths, which encompasses the peak of solar spectral irradiance. The absorption due to BrC, and consequently the reduction in albedo, is heavily influenced by its imaginary refractive index (κ). Recent in situ studies of BrC in snow have retrieved κ and measured albedo, which agrees with model-based predictions. However, BrC relative abundance in snow and its optical properties remain poorly constrained, and the resulting snow albedo and radiative forcing are not fully resolved.

Here we show the response of snow albedo to a broad range of BrC optical properties. The sensitivity analysis is performed using the Snow, Ice, and Aerosol Radiative (SNICAR) model, a two-stream radiative transfer model that calculates the radiative fluxes and surface albedo based on downwelling solar irradiance and particle optical properties. In addition, we identify BrC size distribution and relative abundance as tunable parameters for this sensitivity analysis. Preliminary results using a Kramers-Kronig dispersion relation for κ indicate that an albedo reduction of up to 10% compared to pristine snow occurs in the UV-visible region of the spectrum for 10 ppm of BrC in snow. We anticipate the results from this study will better constrain the albedo reducing effect and surface radiative forcing due to BrC on snow. Furthermore, simulation results may be combined with satellite remote sensing data to estimate ground concentrations of BrC in remote locations.

2CC.3

Hygroscopicity of Internally Mixed Ammonium Sulfate and Secondary Organic Aerosol Particles Formed at Low and High Relative Humidity. Patricia Razafindrambinina, Kotiba A. Malek, Joseph Dawson, Kristin DiMonte, Tim Raymond, DABRINA DUTCHER, Miriam Freedman, Akua Asa-Awuku, *Bucknell University*

Volatile organic matter suspended in the atmosphere such as α-pinene and ß-caryophyllene undergoes aging processes and chemical, and photo-oxidation reactions to create secondary organic aerosols (SOAs), which can influence the indirect effect of aerosol particles and the radiative budget. The presence and impact of water vapor and ammonium sulfate (ubiquitous species in the atmosphere) on the hygroscopicity and CCN activity of SOA have not been well characterized. In this research, three water-uptake measurement methods, cavity ring-down spectroscopy (CRD), humidified tandem differential mobility analysis (HTDMA), and cloud condensation nuclei counting (CCNC), were employed to study the hygroscopicity of α-pinene and ß-caryophyllene SOAs formed by dark ozonolysis. We observed the changes in water uptake of SOAs in the absence and presence of water vapor at 70% RH and ammonium sulfate seeds. Measured hygroscopicity was represented by a single hygroscopicity parameter (k). Sesquiterpene SOA was observed to be insoluble, hydrophobic, and non-hygroscopic under all experimental conditions and at all initial concentrations, as bcaryophyllene SOA exhibited non-hygroscopic properties with values that were effectively 0. Conversely, monoterpene SOA water uptake is sensitive to increasing RH in the chamber during secondary aerosol formation. Dry and wet seeded monoterpene SOA showed a similar trend of increase despite variability in initial precursor concentrations. We conclude that differences in the viscosity, solubility and hydrophobicity of SOAs may be the primary factor that leads to changes in SOA hygroscopicity formed under low and high relative humidity conditions.

2CC.4

Light Absorbing Aerosol-Cloud Interactions. SHREYA JOSHI, Claudio Mazzoleni, Timothy Onasch, Arthur J. Sedlacek, Raymond Shaw, Ian Helman, Susan Mathai, Thusitha Divisekara, Swarup China, Abu Sayeed Md Shawon, Laura Fierce, Yangang Liu, Lynn Mazzoleni, Simeon Schum, Will Cantrell, Jacob Kuntzleman, *Michigan Technological University*

Atmospheric light-absorbing aerosols, such as particles containing black carbon (BC), significantly impact the Earth's radiation budget. These particles interact with solar radiation, scattering, and absorbing light, as well as with clouds. Morphological changes of BC and internal mixing with other materials, such as organic coatings, affect the particle's scattering and absorption properties and their interaction with clouds. These processes have been the subject of previous studies; however, interactions of BC with clouds have received less attention, and important questions remain open. Recently, we started a project designed to investigate these processes in the Michigan Tech cloud chamber (the Pi-Chamber). We will be using BC and BC surrogates and coating surrogates to understand better the effects of aging on aerosol-cloud interactions. Initial experiments were carried out to characterize the dry deposition in the Pi-Chamber for aerodynamically size selected BC particles. Cloud experiments are currently being carried out employing a Pumped Counterflow Virtual Impactor to investigate changes in the morphology of the BC particle aggregates upon cloud activation and evaporation. During these experiments, we study the changes in optical and cloud condensation nuclei properties of interstitial and residual particles. We also characterize the optical and chemical properties of liquid smoke, which will be used as a surrogate for BC coating. Subsequent experiments will focus on the effects of coating material on BC, how these coatings affect aerosol-cloud interactions, and the resulting aerosol and cloud properties. We will provide an overview of the project and some preliminary results.

2CC.5

Microorganisms in Fog and Aerosol at a Rural Site. THUONG CAO, Pierre Herckes, Ferran Garcia-Pichel, Derek Straub, *Arizona State University*

Research on microorganism-mediated conversion of organic compounds in atmospheric water (clouds and fog) has recently gained interest in the bioaerosol community. Most existing work has addressed remote environments (mainly Puy de Dôme, France) and few observations exist on microorganisms and bacterial biotransformation in the United States. In this study, fog and aerosol samples collected recurrently in Selinsgrove (Pennsylvania, USA) from June to November 2021 were investigated. Using 16S rRNA sequencing, we found that the bacterial community of fogs was different from that found in paired aerosol samples. Proteobacteria (Alpha-, and Beta-) largely dominated fog samples, while Alphaproteobacteria, Firmicutes, and Actinobacteria were abundant in aerosol samples. Total DNA concentration in fog samples increased with a greater liquid water content (LWC), which contrasts with the opposite trend observed between ionic content and LWC. Additionally, 31 bacterial species from 17 fog events were isolated onto R2A medium. In lab conditions, biodegradation of formaldehyde by these isolated bacteria tested in an artificial cloud medium at 17°C, resulted in divergent rates, varying from 0 to 10^{-19} mol cell^{-1} s^{-1}. This shows that some but not all bacteria in clouds can indeed contribute to biotransformation processes.

2CC.6

Organosulfates in Nascent and Aged Sea Spray Aerosols.

DILINI KIRINDIGODA GAMAGE, Elias Hasenecz, Glorianne Dorcé, Kathryn Mayer, Jon Sauer, Christopher Lee, Kimberly Prather, Elizabeth Stone, *University of Iowa*

Organosulfates are components of secondary organic aerosols that contain a distinctive sulfate ester functional group (R-O-SO_3^-). Organosulfates in the marine environment can arise from both primary and secondary sources. Liquid chromatography coupled to high resolution and tandem mass spectrometry (MS/MS) with negative mode electrospray ionization was used to determine the composition and abundance of organosulfates in $PM_{2.5}$ nascent and aged sea spray aerosol (SSA) collected during the Sea Spray Chemistry and Particle Evolution (SeaSCAPE) study. Nascent SSA was generated from natural seawater via breaking waves generated in 30 m glass wave channel. Aged SSA was generated by oxidizing the wave channel headspace, including nascent SSA, in an oxidative flow reactor (OFR), and it includes both heterogeneously oxidized SSA and secondary marine aerosol formed by the oxidation of volatile organic compounds. Anthropogenic anionic surfactants including ethylhexyl sulfate ($C_8H_{17}SO_4^-$; 209.0848), dodecyl sulfate ($C_{12}H_{25}SO_4^-$; 265.1474), tridecyl sulfate ($C_{13}H_{27}SO4^-$; 279.1630), and myristyl sulfate ($C_{14}H_{29}SO_4^-$; 293.1787) contributed the most to the bisulfate (HSO_4^-; 97) product ion as determined by precursor-ion MS/MS. These alkyl sulfates likely entered the ocean by runoff and were enriched during SSA production due to their high surface activity. Secondary organosulfates derived from isoprene, monoterpene, fatty acids, and other sources were identified in nascent and aged SSA. Isoprene derived organosulfates (e.g., 2-methyltetrol sulfate, $C_5H_{11}SO_7^-$; *m/z* 215) were greatly enhanced in the sampling channel where marine volatile organic compounds were oxidized. The presence of the precursor ion signal at *m/z* 294, which corresponds to monoterpene-derived organosulfates with a nitroxy functional group ($C_{10}H_{16}NSO_7^-$) in nascent and aged SSA, indicates NO_3-initiated oxidation of monoterpenes in the presence of acidified sulfate in the marine environment. Findings from this study provide molecular insight into the composition of sea spray aerosol and reveal likely primary and secondary sources of organosulfates and their formation pathways in the marine environment.

2CC.7

Measurement of Light-absorbing Iron Oxide Aerosols in Liquid Water with a Modified Single-Particle Soot Photometer.

TATSUHIRO MORI, Yutaka Kondo, Kumiko Goto-Azuma, Nobuhiro Moteki, Atsushi Yoshida, Kaori Fukuda, Yoshimi Ogawa-Tsukagawa, Sho Ohata, Makoto Koike, *Keio University*

We used a single particle soot photometer (SP2) with a CETAC Marin-5 nebulizer to measure size-resolved mass and number concentrations of light-absorbing iron oxide aerosols (FeO_x) in liquid water (C_{MFeOx} and C_{NFeOx}, respectively). The SP2 could selectively detect individual FeO_x particles in a wüstite reference sample and several melted Arctic snow samples. The nebulizer efficiency (ε) for FeO_x particles was about 50% within 70–650 nm diameter range, derived from the ratio of volume of ammonium sulfate before and after extraction of the nebulizer and the size-resolved transmission efficiency in the nebulizer–SP2 sampling line. We corrected the size-resolved C_{MFeOx} at particle diameters larger than 920 nm by using the removal efficiency, which was defined as the ratio of the size-resolved number concentration of FeO_x in hydrometeors to that in air measured at Fukue Island in spring. The uncertainty due to the correction was approximately 10% for C_{MFeOx} and negligibly small for C_{NFeOx}. The uncertainty from differences in the boundary lines used to discriminate between FeO_x and black carbon was also approximately 10%. The overall uncertainties in the total C_{MFeOx} and C_{NFeOx} (220–1200 nm) were approximately 19% and 20%, respectively. We demonstrated that during 16-month storage periods, the FeO_x size distributions in water were stable, and C_{MFeOx} and C_{NFeOx} changed less than 1.0% and 19% on average, respectively. The high accuracy of the C_{MFeOx} and C_{NFeOx} measurements is indispensable to quantitatively understand the wet deposition of FeO_x and accurately estimate the effect of FeOx on snow surface albedo.

2CC.8

Identifying Better Indicators of Aerosol Wet Scavenging during Long-Range Transport. MIGUEL HILARIO, Avelino Arellano, Ali Behrangi, Ewan Crosbie, Josh DiGangi, Glenn Diskin, Michael Shook, Luke Ziemba, Armin Sorooshian, *University of Arizona*

As the dominant sink of aerosol particles, wet scavenging greatly influences particle lifetimes and their downstream interactions with clouds, precipitation, and radiative forcing. However, wet scavenging remains highly uncertain in models, hindering model capabilities to accurately predict aerosol effects. To understand the role of transport conditions on aerosol scavenging, previous studies used enhancement (Δ) ratios of black carbon and carbon monoxide (ΔBC:ΔCO) and accumulated precipitation along HYSPLIT trajectories (APT). However, APT inherently neglects in-cloud scavenging, which is more efficient than below-cloud scavenging at removing submicrometer particles. In this work, we aim to identify an improved indicator of wet scavenging that accounts for both below- and in-cloud processes by assessing an array of scavenging-related predictor variables from satellite retrievals (e.g., APT) and reanalysis (e.g., relative humidity (RH), water vapor mixing ratios). We utilize aircraft measurements of ΔBC:ΔCO over the West Pacific region, which hosts a dynamic transport environment rich in aerosol sources and cloud-precipitation systems. To assess each predictor variable, we applied a general first-order exponential decay model to derive relationships between ΔBC:ΔCO and each predictor variable. Bootstrapping and k-fold cross-validation were implemented to evaluate the robustness of each model fit. We find that among the analyzed predictors, the fraction along trajectories where RH exceeds 95% (fRH95) is a robust improvement upon APT from IMERG when predicting observed ΔBC:ΔCO, with predicted-to-observed regression slopes closer to 1 (fRH95: 0.5; APT: 0.1), higher predicted-to-observed correlations (R = 0.8) than APT (0.2 – 0.3), and approximately 30% lower prediction bias than APT. Analysis also isolates in-cloud scavenging (e.g., fRH95 where APT = 0) and considers other model fits (e.g., logarithmic) to characterize aerosol-scavenging relationships. This work demonstrates a method of assessing alternative indicators of wet scavenging that can be applied in a variety of environments to provide more accurate estimates of aerosol scavenging during transport.

2CC.9

Investigating Vertical Profile of Black Carbon Containing Particles and Their Mixing State at the Southern Great Plains. SUSAN MATHAI, Zezhen Cheng, Nurun Nahar Lata, Darielle Dexheimer, Claudio Mazzoleni, Fan Mei, Swarup China, *Michigan Technological University*

Black carbon (BC) containing particles affect the climate directly by efficiently absorbing solar radiation and indirectly by serving as cloud and ice nuclei to alter the surface albedo. However, light-absorption properties of BC containing particles are highly variable due to limited understanding in their concentration, physiochemical properties, morphology, and mixing state, leading to large uncertainties in their radiative forcing calculation. In this study, we focus on the the vertical distribution of BC and its mixing states by collecting data at Southern Great Plains (SGP) from during February and April, 2022 by deploying instruments on an Atmospheric Radiation Measurement (ARM) tethered balloon system (TBS). We deployed two micro-aethalometers (AE51 and MA200) to monitor the BC concentration at different altitudes along with the condensation particle counter (CPC) for total particle concentration measurement, and a Portable Optical Particle Spectrometer (POPS, Handix scientific) to monitor the size distribution of the particles. We also investigate the absorption Ångström exponent to investigate the brown carbon. Furthermore, we also deployed Environmental Molecular Science Laboratory's automated Size and Time-resolved Aerosol Collector (STAC) to collect particles at different altitude. We use multi-modal microscopy and spectroscopy techniques to analyze collected samples and investigate the morphology and mixing state of BC containing particles. This study will improve our understanding of BC particles mixing state, and their variations along vertical column of the atmosphere.

2CC.10

Aging Induced Changes in Hygroscopicity and CCN Activity of Black Carbon Particles from Biomass Burning. OGOCHUKWU ENEKWIZU, Arthur J. Sedlacek, Ernie R. Lewis, *Brookhaven National Laboratory*

Biomass burning (BB) is a major source of atmospheric black carbon (BC), which affects climate both directly through absorption of solar radiation and indirectly by changing cloud properties such as cloud amount and lifetime. BB events also concurrently release an abundance of condensable organic vapors that form very thick coatings that encapsulate the BC. These coatings increase the hydrophilicity of the otherwise hydrophobic BC particles while at the same time increase the particle size, both of which enhance the ability of these particles to act as cloud condensation nuclei (CCN). Due to the complex interplay between hydrophilic properties of the coating and the hydrophobic properties of the BC “core”, along with the particle size, better quantification of the hygroscopic properties for this important class of particle needs to be achieved if we are to improve our understanding of the direct and indirect climatic forcing contributions by these particles. To this end, we are conducting laboratory measurements of the CCN activity of pure and thickly coated BC surrogate particles under typical atmospheric supersaturations using levoglucosan, a known tracer for BB, as a proxy for fresh organic coating and oleic acid as a surrogate for aged organic coating, as a function of coating thickness for different core (i.e., BC) diameters, and we compare our experimental results with theoretical calculations derived from κ-Kohler theory. The limiting cases of fresh and aged organic coatings, which span the range of coating properties, will be used to investigate the activation behavior of an ensemble BC particle population and how this, in turn, affects its optical properties. Our findings will a provide critical fundamental-level understanding of aerosol-cloud interactions for this important class of particle.

2CC.11

Supercooled Organics Inhibit Freezing. SAMANTHA GREENEY, Brianna Hendrickson, Jessica Mirrielees, Sarah Brooks, *Texas A&M University*

Viscous aerosol particles may provide flexible surfaces which promote ice nucleation. However, the ability of viscous aerosol particles to act as ice nucleating particles (INPs) is not well characterized. In this study, viscosity was determined for aqueous organic solutions (citric acid, sucrose, maltose, glyoxal, and methylglyoxal) at varying weight percent (40%, 50%, and 65%), saturated solutions (citric acid, sucrose, maltose, and ammonium sulfate), and three eutonic solutions (composed of ammonium sulfate and one organic compound). Viscosity of each solution was measured at a range of temperatures. According to the measurements, it was determined each solution was in the liquid phase except for the 65 weight percent glyoxal solution which reached the semi-solid regime ($>10^3$ poise) at -23°C. Additionally, a custom-built freezing stage was used to determine the immersion ice nucleation temperatures. The saturated citric acid solution and the ammonium sulfate/citric acid eutonic solution remained liquid until -80°C indicating they were supercooled droplets. Since viscosity increases as temperature decreases, these results indicate that particle phase may restrict the range of altitude at which organic aerosol can serve as INPs. Additionally, these organic solution droplets will remain liquid in the upper troposphere and stratosphere.

2CC.12

pH Dependence of Brown Carbon Absorbance in Cloud Water. CHRISTOPHER HENNIGAN, Sara Lance, Bryanna Boegner, Grace Bounds, Lucia Garcia, Michael McKee, Madison McLaren, Vikram Pratap, Jasper Reno, Shawn Serafin, *University of Maryland, Baltimore County*

Light-absorbing organic species present in aerosols, collectively called brown carbon (BrC), contribute important but highly uncertain effects on climate. Among absorbing species present in aerosols, BrC is unique because it is both emitted directly into the atmosphere (primary BrC) and formed from gas- and aqueous-phase reactions (secondary BrC). It is also unique because reactions initiated by oxidants and UV light can rapidly transform chromophores into non-absorbing (or more weakly absorbing) species in a process called bleaching. Clouds likely represent a significant medium for the production of secondary BrC and for a variety of bleaching reactions, though the relative importance of formation and loss processes in clouds is unknown at present. The acidity (or pH) of atmospheric particles and clouds affects the optical properties of BrC and bleaching rates, although the link between pH and BrC is yet another uncertainty in attempts to constrain its climate forcing effects. Given the wide variability of pH in the atmosphere (pH in particles and clouds ranges from -1 to 8), the optical properties of BrC and its bleaching behavior are expected to vary significantly in the atmosphere, as well. In this work, we characterize the pH dependence of BrC optical properties – including light absorption at 365 nm, mass absorption coefficient (MAC_{365}), and the absorption Ångström exponent (AAE) – in cloud water sampled from Whiteface Mountain, NY. The cloud water composition is used to inform thermodynamic predictions of aerosol pH upwind/downwind of Whiteface Mountain and the subsequent changes in BrC optical properties. Differences in BrC optical properties are linked with air mass history and cloud water composition to infer source influence.

2CC.13

Elucidating New Particle Formation in Complex Terrain during the Winter 2022 CFACT Campaign. Anna Gannet Hallar, Eric R. Pardyjak, Sebastian W. Hoch, Zhaoxia Pu, GERARDO CARRILLO-CARDENAS, *University of Utah*

New particle formation (NPF) is a complex atmospheric phenomenon characterized by the sudden burst and growth in aerosol particles. Depending on its intensity and growth, NPF can contribute to aerosol loading in urban and remote regions, degrading air quality and inhibiting public health. Previous studies have shown that NPF contributes to the formation of cloud condensation nuclei (CCN), changing the overall composition of clouds and modifying their effects on climate. Over the past 20 years, numerous field studies have improved our understanding of NPF and highlighted possible chemical and physical processes required to initiate NPF. For instance, Boundary-Layer mechanisms such as turbulent mixing lead to the decoupling of different atmospheric reservoirs that help initiate NPF. However, it is not easy to quantify how a specific process influences NPF due to complex physical interactions between the atmosphere, land surfaces, and intricate chemical precursors needed for aerosol formation. The research presented here will help better understand which atmospheric processes enhance or limit NPF. This research uses observations from an extensive field study, CFACT (Cold Fog Amongst Complex Terrain), conducted in the Heber Valley of northern Utah during the winter of 2022. In situ measurements and derived variables will be incorporated into a positive matrix factorization model (PMF) to quantify the role of specific boundary-layer processes and meteorological variables on NPF. We use a radiative transfer model to compare observed and modeled UV radiation outputs and investigate the effect of radiative energy exchange on photochemistry for NPF. Results from this research will elucidate the interface between Boundary-Layer processes and NPF. Doing so will help inform air quality policy in mountainous terrain and address climate concerns.

2CC.14

Hygroscopicity of Polycatechol and Polyguaiacol Secondary Organic Aerosol in Sub- and Supersaturated Water Vapor Environments. KOTIBA A. MALEK, Kanishk Gohil, Hind Al-Abadleh, Akua Asa-Awuku, *University of Maryland*

Biomass burning is a major source of primary atmospheric aerosols whose hygroscopic and optical properties contribute to aerosols indirect and direct effect on the climate. Biomass burning is also a source of a variety of gases that lead to secondary organic aerosol (SOA) formation. During their residence time in the atmospheric, biomass burning gases and particles undergo mixing and aging processes that change their chemical and physical properties. For example, iron (Fe), which is a component of mineral dust, sea spray and biomass emissions catalyzes aqueous phase oligomerization reactions that convert phenolic compounds catechol and guaiacol into light-absorbing and water-insoluble particles, namely polycatechol and polyguaiacol. In this presentation, the cloud condensation nucleation (CCN) efficiencies of polycatechol and polyguaiacol under sub- and supersaturated environments were quantified using the single hygroscopicity parameter (κ). Our results show that both polycatechol and polyguaiacol are CCN active with κ-values ranging from 0.03 to 0.25 with polycatechol being more hygroscopic than polyguaiacol under subsaturated (κ =0.13 vs κ=0.03) and supersaturated conditions (κ =0.25 vs κ=0.16). This difference in hygroscopicity is attributed to structural differences. The implications of our results on aerosol hygroscopic properties will be presented.

2HA.1

Deposition Simulator for Tobacco Aerosol in the Human Respiratory System. AKINA MORI, Shigeaki Ito, Takashi Sekine, *Japan Tobacco Inc.*

The assessment of the health impact of tobacco aerosol requires an understanding of the aerosol behavior and deposition amount in the human respiratory tract. Computer fluid dynamics (CFD) modeling has generally been adopted to predict such information. However, the CFD modeling of tobacco aerosol has a high calculation cost and is not conducted for the whole airway system owing to the complex nature of tobacco aerosol and the respiratory system. To assess a number of chemical constituents and mixtures in the overall respiratory system, we modified the existing multiple-path particle dosimetry (MPPD) model, which is a non-CFD deposition simulator of aerosol. Our new version of the MPPD model accounts for the mixing of the puff in the oral cavity and deep lung and the air–tissue interaction of constituents in the gas phase. Considering the aerosol properties, constituents' physicochemical properties, and user topography, the model estimates the change in the droplet diameter through the respiratory tract and the deposition fraction of chemical constituents of interest in one puff of a tobacco product, such as a conventional cigarette or electronic nicotine delivery system. Sensitivity analysis reveals that known important parameters (e.g., the vapor pressure, particle diameter, and activity coefficient) work properly in our model, and the changes in the aerosol deposition due to changes in the parameters are consistent with previous knowledge. Importantly, the prediction was carried out within 3 minutes even with 10 constituents, demonstrating the successful reduction of the calculation cost and time. The new version of the MPPD model is thus a time-saving and effective tool with which to estimate the multi-constituent aerosol especially for tobacco products.

2HA.2

Experimental Study on the Effects of Temperature and Humidity on the Deposition of Nebulized Droplets in a Simplified Mouth-Throat Airway Model.

YUEYANG CAI, Huizhen Yang, Xiaole Chen, Ting Ding, *Nanjing Normal University*

The transport and deposition of saline droplets in human respiratory tract are complex due to droplet evaporation. The aim of this study is to experimentally investigate the effects of environmental temperature and humidity on the deposition of saline droplets in a simplified mouth-throat airway model. The normal saline droplets were generated from a vibrating mesh nebulizer (Youwell HL100A). The deposition fractions (DFs) of nebulized saline droplets in the MT airway model were compared under three conditions: 1) indoor condition, T=26.5℃ and RH=50% and 2) cool and dry, T=15℃ and RH=40% and; 3) hot and humid, T=30°C and RH=75%. The results suggested that, for all three environmental conditions, the DF of the saline droplets firstly decreased with the increase of the inhalation flow rate from 15 L/min to 22.5 L/min. Then the DF gradually increased with the increase of the inhalation flow rate from 22.5 L/min to 60 L/min. For a given inhalation flow rate, warmer and more humid environment led to higher DF of the saline droplets in the MT airway. The DFs of the droplets under Condition 3 were 8.3% to 22.6% higher than those under Condition 2 at different inhalation flow rates.

2HA.3

Determining the Effect of Age and Head Position on Aerosol Delivery to Turbinate Regions of Human Intranasal Airways.

JANA KESAVAN, Kristina Kuypers, Douglas Sommerville, Beth Laube, *US ARMY DEVCOM CBC, Aberdeen Proving Ground, Maryland*

Many drugs are delivered intranasally to adults and children. However, little is known of the effect of age and head position on aerosol delivery to the turbinate regions. This study quantified turbinate deposition in anatomically correct models of the intranasal airways of an 18 year old male, a 5-year-old male and a 2-year-old female, constructed with 3D-printing technology. Each model consisted of a face with nostrils plus top, middle and bottom sections that contained superior, middle and inferior turbinates, respectively. Each model was tested 6 times sitting with head tilted back at 45 degrees (sitting45), supine, and supine with head tilted back at 45 degrees (supine45). Aerosol was delivered through a mucosal atomization device (MAD^{TM}) attached to a one mL syringe. There was no air flow through the model. Syringes were filled with 0.25mL of 0.9% sodium chloride solution mixed with fluorescein. Following aerosol administration, model sections were individually rinsed in water and samples tested for fluorescence using a fluorometer. The amount of fluorescence in each sample represented the amount of aerosol deposited in each section and was expressed as a percent of fluorescence detected in a reference sample. For the 18 and 5-year-old models, deposition to the superior turbinate was optimized in the supine45 position and to the inferior turbinate in the supine, or sitting45 positions. Deposition to the middle turbinate was similar for the three positions. In contrast, for the 2-year-old model, deposition to the superior turbinate was similar for the three positions, whereas, deposition to the inferior turbinate was optimized in the sitting45 position and to the middle turbinate in the supine45 position. These results show that both age and head position play a major role in aerosol delivery to human nasal turbinate regions, using the MAD^{TM} delivery device.

2HA.4

Performance of Different Nebulizers for Bronchial Challenge Testing. TAEWON HAN, Jennifer Therkorn, Michael Falvo, Gediminas Mainelis, *Rutgers, The State University of New Jersey*

Chronic respiratory health conditions, i.e., asthma, rhinitis, and sinusitis, affect a high number of military personnel , especially Veterans who served in the Southwest Asia theater of operations. At the same time, diagnosing asthma is difficult due to a lack of a gold standard test, and many cases may be misdiagnosed.

Bronchial challenge testing, specifically methacholine challenge testing (MCT), is a mainstay in the assessment of asthma. The constriction caused by MCT aerosol allows determining how “reactive” an individual’s lungs are to a certain concentration of the drug, helping to diagnose asthma. The accuracy of this test depends on the delivered drug dose, which is determined by the breathing time and pattern, drug concentration in a nebulizer, and the nebulizer characteristics. The latter component, however, is rather poorly characterized, leading to uncertainty in the delivery of methacholine and may affect accuracy of the test.

Thus, the goal of this project was to characterize aerosol output from different nebulizers used in the MCT challenge and also test the effects of different breathing patterns on MCT delivery. One of the goals was to determine the PM5 aerosol fraction, i.e., dp < 5 µm in aerodynamic diameter, produced by various nebulizers and different drug concentrations, as this fraction is used by medical personnel to calculate the delivered MCT dose. The examined nebulizers included AeroEclipse II BAN, AeroGen, and MicroMist. The data show that the nebulizer output characteristics, such as total mass and PM5 fraction depend on a nebulizer type, drug concentration (e.g., 0.0625, 0.25, 1, 4, and 16 mg/mL), and breathing pattern (e.g., healthy and asthmatic individual). We also observed that the PM5 fraction varies between 50 and 70%. The obtained data will be used to construct an information sheet for medical professionals administering the MCT challenge.

2HA.5

Exposure to Black Carbon and Deposition on Lungs. ABDULLAH KHAN, Sergej Semcuk, Lina Davulienė, Agnė Minderytė, Mehri Davtalab, Kamilė Kandrotaitė, Julija Pauraite, Inga Garbarienė, Vadimas Dudoitis, Kristina Plauškaitė, Steigvilė Byčenkienė, *SRI Center for Physical Sciences and Technology, Lithuania*

The International Agency for Research on Cancer (IARC) has identified particulate matter (PM) as a major cause of lung cancer, based on a large body of research. Elevated mass concentrations of PM and black carbon (BC) have been associated with adverse health effects. Particulate matter has been associated with premature death from heart and lung disease, strokes, heart attacks, chronic respiratory diseases including bronchitis, exacerbation of asthma, and other cardio-respiratory symptoms. BC is the main component of PM and is found to be more harmful than PM2.5 (the mass concentration of all particles below 2.5 µm).

Black carbon mass concentration, aerosol particle count concentration and size distribution measurements were performed during 1-31 March, 2022 in an urban background station in Vilnius, Lithuania (capital city of Lithuania with over 600 000 inhabitants). For street-level BC pollution assessment portable micro-Aethalometer (AethLabs model MA200) was used to measure the equivalent BC mass concentration with a time resolution of 30 s and a flow rate of 150 mL/min. BC maps was calculated based on measured concentrations associated with location GPS as a result of data collected along the home-office-home route in and outside car. In our study, BC pollution maps showed a significant increase in BC levels along traffic routes, as expected. Highest contribution of traffic related BC to total BC was recorded during daytime (8:00 AM – 6:00 PM local time). Meanwhile wood burning related BC contributed 34% to total BC mass concentration over the whole measurement campaign with increased contribution during night-time (up to 42% at 4:00 AM local time). The MPPD model was used as a computational tool to calculate the deposition and removal of polydisperse aerosol in the respiratory tract.

2HA.7

External Factors Modulating Vaping-Induced Thermal Degradation of Vitamin E Acetate. ALEXA CANCHOLA, Ruth Meletz, Siri Langmo, Michael Lum, Ying-Hsuan Lin, *University of California, Riverside*

Exposure to vaping emissions has become a major public health concern in the United States. Studies indicate the vaping process causes breakdown of e-liquids into potentially toxic degradation products. Efforts have been made in predicting the compounds that a particular e-liquid may degrade into, and users may be exposed to. However, while most models simulate thermal decomposition of e-liquids under pyrolysis conditions, numerous factors – including vaping behavior, device construction, and surrounding environment – may impact the thermal degradation process. Vitamin E acetate (VEA) has been found to degrade at low temperatures (< 200 °C) into duroquinone (DQ) and other compounds, despite previous computational models indicating that DQ formation should not occur until 500-600 °C. We hypothesized that the presence of molecular oxygen and transition metals in the e-cigarette body promote thermal oxidation of e-liquids, resulting in greater degradation than predicted by pure pyrolysis. Using a tube furnace reactor, VEA was heated in inert (N_2) and zero air environments in the absence and presence of Ni-Cr and Cu-Ni alloy nanopowders, which are known components of heating coils. Vaping aerosols were analyzed by gas chromatography/mass spectrometry (GC/MS) to assess the impact of the environments on degradation product formation. Thermal characteristics of VEA were also assessed using a combination of thermogravimetric and differential scanning calorimetry analysis. In N_2 environments without the presence of metals, VEA does evaporate until 240 °C, and no substantial formation of degradation products could be observed even at the maximum temperature setpoint. Conversely, substantial degradation of VEA into DQ and various carbonyls in zero air environments was observed, even in the absence of metals, highlighting the importance of oxidation reactions during degradation processes. This study indicates additional mechanisms and external factors that should be considered to help improve predictions of thermal degradation products from e-liquids.

2HA.8

Examining the Influence of Electronic Cigarette Aerosols on Cell Viability and Membrane Integrity for Lung Epithelial Cells. KAPIAMBA KASHALA FABRICE, Hsin-Yin Chuang, Yue-Wern Huang, Yang Wang, *Missouri University of Science and Technology*

Chemical characterizations of electronic cigarette (EC) aerosols have revealed considerable concentrations of nicotine, flavoring chemicals, and metal particles (Kapiamba et al., 2022) that may lead to health complications in case of excessive and extended use. Several studies in vivo have revealed that exposure to EC aerosols induces reactive oxidative species, DNA damage, and cell death in vascular endothelial cells ad tissue explants. However, due to the methods for aerosol exposure, few studies mimicked environments and conditions similar to the actual aerosol exposure in the lungs/respiratory system.

This study examines the cell viability and membrane integrity of the lung epithelial cells (A549) exposed to primary and secondhand EC aerosols. We exposed the cells to EC aerosols through an air-liquid interface and used two types of EC devices (VUSE and VOOPOO). In addition, we assessed the effects of nicotine concentration in the vape liquid and the EC power settings. Results show that 24 hours after EC aerosol exposure to primary and simulated secondhand aerosols, cell viability declined to approximately 45% and 85%, respectively. We also found that cell viability is inversely proportional to power setting and nicotine concentration in the vape liquid. Moreover, the 30-puff smoke exposure reduced transepithelial electrical resistance (TEER) to 66% of the control group with a mean absolute value of $\sim 61\ \Omega*\text{cm}^2$ compared to $\sim 94\ \Omega*\text{cm}^2$ of the control group. Our study adds value to the current knowledge on the toxicology of EC aerosols under more realistic testing conditions.

Kapiamba et al., accepted.
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2HA.9

Development of Openable Small Cyclone Device and Its Application to Particle Toxicity Assessment. NAKANO KOHEI, Hyunwoo Youn, Ayumi Iwata, Tomoaki Okuda, *Keio University*

In recent years, there has been growing interest in the health effects of fine particulate matter (PM2.5) . The chemical properties of PM2.5 vary from collection point to collection point and are likely to strongly influence the toxicity assessment of PM2.5. Generally, PM2.5 is collected by filters, but this means that filter components can affect the results when analyzing PM2.5 composition and assessing its toxicity. The cyclone method, however, can collect PM2.5 directly as a powder without being affected by filter components.

In order to directly collect PM2.5 with different chemical properties at multiple locations, our laboratory developed a portable cyclone device using a small cyclone. However, with this small cyclone (conventional cyclone), it was difficult to remove all particles adhering to the inner wall, and aluminum, the material of the cyclone, was contaminated in the sample. Therefore, in this study, we fabricated a new openable cyclone, which was the same dimensions as the conventional cyclone and made of stainless steel. Then, we evaluated its performance.

In the performance evaluation, we first made a separation efficiency curve for the openable cyclone at a test flow rate of 90 LPM. The measurement results showed that the 50% cut-off diameter of the openable cyclone was approximately 0.13 µm, which was comparable to the performance of a conventional cyclone measured under similar conditions. Next, we collected PM2.5 in Yokohama using the openable cyclone in parallel with a conventional cyclone. The openable cyclone was able to collect particles adhering to the inner wall, improving the yield by about 25%. In addition, the results of component analysis showed no aluminum contamination, thus solving the problem of conventional cyclones.

The newly developed openable cyclone enabled more accurate toxicity comparisons based on differences in the chemical composition of particles between locations, without the influence of filter components.

2HA.10

Effect of Combustion Particle Morphology on Biological Responses in a Co-culture of Human Lung Epithelial and Macrophage-Like Cells. KAMALJEET KAUR, Raziye Mohammadpour, Hamid Ghandehari, Chris Reilly, Robert Paine, Kerry Kelly, *University of Utah*

Atmospheric aging of combustion particles alter their chemical properties and morphology from a fiber-like to more compact and spherical. Previous studies of fresh and aged combustion particles have suggested that the changing chemical composition is the prime cause of the observed differences in toxicological response. However, little is known about the contribution of morphological changes in atmospherically aged particles to their toxicological response, possibly due to the difficulty in resolving the two properties (composition and morphology) that change simultaneously. A method to change particle morphology without the need to change chemical composition would help elucidate the effect of this morphological change on cellular responses. This study altered the shape of lab-generated combustion particles from fiber-like to a more compact spherical shape using water condensation and evaporation. Quantitative comparison of polycyclic aromatic hydrocarbons and semi-volatiles for both shapes (altered and not-altered) confirmed no significant change in composition. Using an electrostatic field-based air-liquid exposure (ALI) chamber, the two shapes were exposed to a co-culture of human airway epithelial (A549) and differentiated human monocyte (THP-1) cells. For the same mass dose of 2 µg/cm^2, both shapes were ingested by cells, induced a pro-inflammatory response (IL-8 and TNFα) and enhanced CYP1A1 gene expression compared to air controls. The more compact spherical particles (representative of atmospherically aged combustion particles) induced more early apoptosis and release of TNFα compared to the more fiber-like particles. The result suggests a contribution of morphology to the increased toxicity of aged particles.

2HA.11

Activity and Interaction of Iron, Copper, Lead and Other Metals in the Hydroxyl Radical and Dithiothreitol Assays under Physiological Conditions. JIAQI SHEN, Catherine Banach, Chris La, Suzanne E. Paulson, *University of California, Los Angeles*

Metals have been recognized as potentially harmful components in $PM_{2.5}$ as they contribute to aerosol oxidative potential either by themselves or interactions with organic compounds. However, only a handful of studies have investigated responses in the oxidative potential assays from metals. Further, data are available mostly for iron and copper, despite numerous studies that report positive correlations between oxidative potential and other metals such as Ba, Pb, Sb, etc. In this study, we measured the activity of individual metals including Fe, Cu, Ba, Zn, Hg, Pb and Sb in the hydroxyl radical (OH) and dithiothreitol (DTT) assays in surrogate lung fluid. Some metal combinations were also tested to find out potentially important interactions of metals in aerosol oxidative potential. We found that Fe(II), Cu(II) and Cu(I) are the most active metals in the OH assay. While both Cu(II) and Cu(I) are dominant metals in the DTT assay, Cu(I) activity might be due to complex formation between Cu(I) and DTT. The complexation may also explain the low level of activity of Zn(II) in the DTT assay as a non-redox-active metal. We also observed an antagonistic effect between Pb(II) and Cu(II) in both assays. 1 µM Pb(II) decreased the DTT activity of 1 µM Cu(II) by 15% and completely suppressed OH activity of 1 µM Cu(II). While metal-organic interactions are not yet clear, this finding indicates that studies only using well-recognized active metals and organics to predict overall aerosol oxidative potential may overestimate the contribution of metals.

2HA.14

Performance of N95 Filtering Facepiece Respirators Used with Skin Protectants: Manikin-based Study. XINYI NIU, Sergey A. Grinshpun, Michael Yermakov, Roman Jandarov, Iliya Rivkin, *University of Cincinnati*

Continuous wearing of N95 filtering facepiece respirators (FFRs) during the COVID-19 pandemic have often led to adverse skin conditions, such as dryness/tightness and scaling. Skin protectants are widely used to reduce or avoid these impairments. A recent study conducted by our research group explored whether wearing skin protectants impacts the performance of FFRs; however, the above-mentioned study involved human subjects and as such generated results which were affected by the individual variability.

As an alternative, a standardized protocol was deployed, utilizing the NIOSH advanced static manikin headform connected to Breathing Recording and Simulation System to simulate a sinusoidal breathing pattern. The tests were performed using three N95 FFRs (3M 8210, 3M 1870+, and AOSafety 1050), five skin protectants (two fabric tape-like and three gel/cream-like) and two breathing flow rates (30 and 85 L/min). The Total Inward Leakage (TIL) was quantified as the ratio of the aerosol concentrations measured inside and outside the respirator. The aerosolized particles of NaCl served as the challenge aerosol.
This investigation revealed that the TIL value was significantly affected by the interaction of the three variables such as a skin protectant type, breathing flow rate and an FFR model. The data suggest that various types of skin protectants may impact the TIL differently, by either increasing or decreasing the TIL value. Either tape- or gel/cream-type protectants may improve the performance of both tested 3M FFRs as quantified by the TIL; however, when testing with AOSafety 1050 FFR, a negative effect of a skin protectant on the respirator performance was found for either group. The data obtained in this effort will help establish appropriate respiratory protection protocols for healthcare professionals and other individuals wearing respirators with skin protectants.

2HA.15

Assessment of PM Exposures during Commute in Megacity of Karachi, Pakistan. HAIDER KHWAJA, Kamran Khan, Sumayya Saied, Azhar Siddique, Saiyada Masood, *University at Albany*

Karachi is the largest city of Pakistan, with a population of more than 20 million. The rapid and continuing increase in the population, urbanization, automobiles, and industries combined with climate change and geogenic conditions have resulted in severe ambient air pollution problems in Karachi with serious health impacts. No systematic measurements of air pollution in urban cities of Pakistan have been done until now. To assess the extent of personal exposure and quantification of the particulate matter (PM) concentration, we conducted the first mobile PM monitoring campaign in Karachi. A portable laser-operated aerosol mass analyzer AEROCET 531 was used to record geo-located size-segregated PM mass (TSP, PM10, PM7, PM2.5, and PM1) concentrations. Seven in-vehicle tracks in different commercial regions of Karachi were studied. All routes are characterized by heavy traffic volumes with a variety of vehicles running with different type of fuels. Maps of routes were generated by using ArcGIS 10.1® software and IDW tool was used to generate the spatial interpolations of the PM. Mean concentrations across the seven tracks were: TSP (685.3 µg/m3), PM10 (527.1 µg/m3), PM7 (385.5 µg/m3), PM2.5 (51.9 µg/m3) and PM1 (8.7 µg/m3). PM concentrations showed strong spatial variability along each track. High volume of traffic, industries, construction work, and re-suspension of particles all collectively gives rise to high PM concentrations and posing the threatening effect to micro- environment and human health.

2HA.16

Fate of Inhaled Particles in the Lungs of Ferrets. BAHMAN ASGHARIAN, Michael Oldham, Owen Price, *Applied Research Associates, Inc.*

Ferrets have been recommended as an animal model in inhalation toxicology due to the ease of handing, utility in vaccine research and similarities to humans' tracheobronchial geometry. Currently, there is no widely available particle dosimetry model for the ferret, that can be used to estimate inhaled doses or used for interspecies extrapolation. While transport mechanisms and thus deposition models are similar among most mammals and rodents, lung geometries and physiologies are species-specific. We developed a simplified computational lung geometry for ferrets based on available measurements in the literature (Oldham et al., 1990; Laboratory Animal Science 2:186-191). To accurately reflect the structure, a double-path tree branching structure was used for the tracheobronchial tree where one pathway accounted for the conducting airways and the second for the alveolar airways if present (airway generation 5 and beyond). The major advantage of the new geometry was that it avoided artificial separation of conducting and alveolar regions based on airway generation number particularly for lung geometries with monopodial structures prevalent in rodents. The proposed geometrical structure can replace typical-path models, often used in the literature, to predict particle deposition more accurately in all species. Ferret-specific lung volumes and breathing parameters were used to predict particle deposition in the ferret using the Multiple-Path Particle Dosimetry model (MPPD, Applied Research Associates, Raleigh, N.C.). Model predictions showed that while regional deposition followed a similar pattern to that of typical-path models, deposition distribution as a function of airway generation number was significantly different. Deposition of micrometer-sized particles tended to deposit in proximal airway generations whereas nanoparticle deposition occurred in more distal airways. The developed ferret model provides a more realistic prediction of particle deposition distribution in the respiratory tract of ferrets and will be a useful tool for risk assessment applications.

2HA.17

Sars-Cov-2 Filter Forensics in Large, Multi-Story, Residential Buildings: Modeling and Experimental Results.

DAVID JARMA, Juan Pedro Maestre, Atila Novoselac, Kerry Kinney, *University of Texas at Austin*

The COVID-19 pandemic has highlighted the critical role of adequate building ventilation and filtration in mitigating SARS-CoV-2 exposure indoors. The dust recovered from heating, ventilation and air conditioning (HVAC) filters is one promising method for capturing and monitoring SARS-CoV-2 signal indoors. Molecular signal for SARS-CoV-2 has been recovered from HVAC filters both in homes and in larger settings (Maestre 2021, Renninger 2021); However, it is not yet known if it is feasible to monitor the health of large, multi-story, residential buildings using dust samples recovered from the filter banks in centralized air handling units.

With knowledge of the HVAC system configuration and settings, a model was created to estimate the SARS-CoV-2 signal on the HVAC filters. This is important because enough dust mass must collect on the filter over time in order to provide a good sample; Sampling too frequently will not provide enough dust to see a signal, while too much time between sampling begins to defeat the purpose of a monitoring system. Using this model, an appropriate sampling schedule can be implemented, allowing an ample sample mass to be collected.

On three occasions, composite dust samples were collected from the HVAC filters in 8 AHUs. Additional dust samples were collected from the floor, return air grill, and other horizontal surfaces in a random selection of 25 residential units across three zones served by the previously sampled AHUs. Positive SARS-CoV-2 signal was consistently captured and detected in AHU HVAC filter dust. Across the three sampling events, detectable signal ranges in concentration from 102 to 106 copies N2 per gram of dust, comparable to those found in a COVID-19 home study (Maestre et al., 2021). It is important to note that a positive signal indicates that viral (RNA) material is present but does not provide any information about infectivity. The SARS-CoV-2 molecular signal can persist for up to one month in dust samples (Renninger 2021).

Results to date indicate that the SARS-CoV-2 molecular signal is readily detected in HVAC dust collected from AHUs in a multi-story, residential building. This data will be helpful for environmental monitoring of buildings as proactive COVID-19 testing within communities declines, and we need additional methods for identifying whether another outbreak may be imminent. These results indicate that the signal recovered from HVAC filters in AHUs is one potentially effective approach.

2HA.18

Sources of Oxidative Potential (OP) of Ambient Fine Particulate Matter in the Midwestern United States.

Haoran Yu, Yixiang Wang, Joseph V. Puthussery, VISHAL VERMA, *University of Illinois Urbana-Champaign*

Although oxidative potential (OP) of ambient fine particulate matter ($PM_{2.5}$) has been widely recognized as a more health-relevant indicator compared to $PM_{2.5}$ mass concentration, multiple previous studies observed different spatiotemporal patterns of different OP endpoints, indicating the importance of measuring multiple endpoints to obtain a comprehensive assessment of PM-associated oxidative stress. In this study, we analyzed water-soluble OP of $PM_{2.5}$ samples (N > 200) collected from five sites in the Midwestern US throughout an entire year (2018 – 2019) with five acellular OP endpoints [consumption of ascorbic acid (AA) and glutathione (GSH) in a surrogate lung fluid (SLF), OP^{AA} and OP^{GSH}; depletion of dithiothreitol (DTT), OP^{DTT}; and generation of ·OH in SLF and DTT, $OP^{OH\text{-}SLF}$ and $OP^{OH\text{-}DTT}$]. Detailed chemical composition of these $PM_{2.5}$ samples, including inorganic ions, carbonaceous species, and water-soluble trace elements were also measured. Our results showed strong correlations between multiple OP endpoints and OC and several transition metals (i.e., Cu, Fe, Mn, and Zn) at various sites, which are attributed to the high redox activity of these components. Some other species, including EC and K, were also moderately correlated with most OP endpoints at all sites during winter, implying the significance of their associated sources, e.g., biomass burning to OP. Source apportionment results obtained from the positive matrix factorization (PMF) model found very different profiles of the identified sources for their contribution to OP vs. $PM_{2.5}$ mass concentration. Anthropogenic sources, including industrial emissions, vehicular-associated emissions at urban sites, and agricultural emissions at rural sites, although accounted marginally for $PM_{2.5}$ mass (6.1 – 20.8 %), had significant contributions to various endpoints (17.4 – 64.3 %). In contrast, bulk sources like biomass burning and secondary nitrate, although accounting largely for $PM_{2.5}$ mass (16.4 - 27.4 %), contributed lesser to many OP endpoints (<20 %) compared to their mass fractions. Essentially these results indicate that the contribution of various emission sources to the $PM_{2.5}$ mass may not necessarily equate with their contribution to $PM_{2.5}$ overall health risks, and thus demonstrate the need of developing alternative metrics to control $PM_{2.5}$ emissions.

2HA.19

Gas-Particle Partitioning of Nicotine from Common Inhalation Tobacco Products. CONOR A. RUZYCKI, Hammad Irshad, Jacob D. McDonald, Philip J. Kuehl, *Lovelace Biomedical*

The World Health Organization specifies that there is no safe level of exposure to tobacco. Despite this, tobacco use remains high, and newer products such as e-cigarettes have led to a resurgence of tobacco use in youths. The disparate mechanisms of aerosol generation from these different classes of tobacco products are thought to cause differences in aerosol characteristics and gas-particle partitioning of nicotine, ultimately influencing pharmacokinetics and pharmacodynamics during use. In this pilot study, we experimentally characterize gas-particle partitioning of nicotine in aerosols generated by cigarettes (Kentucky Reference), e-cigarettes (including NJOY Traditional Bold, Vuse, and Blu Hi Classic), and an inhalation cessation therapy (Nicotrol Inhaler), using the Health Canada Intense regimen. An annular denuder (URG Corporation) and filter, both coated with oxalic acid, were placed in series downstream of the inhalation product to capture nicotine in the gas phase and particle phase, respectively. Following collection of a puff from each product, the denuder and filter were assayed for nicotine mass using gas chromatography – mass spectrometry. Significant differences in the total amount and partitioning of nicotine between the gas and particle phase were observed between different products: the average total mass of nicotine and the fraction in the gas phase (n=3) ranged from 3.1 µg and 0.91 with the Nicotrol Inhaler to 70.3 µg and 0.23 with the Kentucky Reference Cigarettes, with e-cigarettes yielding total masses between these extremes and gas fractions similar to that of the Kentucky Reference Cigarette. Such differences are expected to result in differences in nicotine pharmacokinetics during use *in vivo*, and future work will investigate gas-particle partitioning in additional classes of tobacco inhalation products.

2HA.20

Impact of Urban Air Quality on Health Studied at the Laboratory with the POLLURISK Platform: Preliminary Results of Innovative Studies of the H2020 REMEDIA Program. PATRICE COLL, Sophie Lanone, Marion Blayac, Zhuyi Lu, Clement Buissot, Celine Yegen, Elie Al Marj, Juan Camilo Macias Rodriguez, Lucy Gerard, Aline Gratien, Mathieu Cazaunau, Cécile Gaimoz, Edouard Pangui, Antonin Bergé, Servanne Chevaillier, Gael Noyalet, Thomas Bertin, Inès Louison, Stephane Jamain, Audrey Der Vartanian, Laurent Boyer, Frederic Relaix, Geneviève Derumeaux, Emeric Cossart, Jean-François Doussin, *LISA UMR CNRS 7583, France*

Summary

Taking benefit of the PolluRisk platform (described in a section of this poster), we report here first biological/toxicological results regarding **exposure of preclinical models to complex simulated atmospheric environments**, representative of urban environments as Paris or Beijing ones.

Introduction

Following ethics guidelines, we exposed different murine models to simulated complex (aerosol and gas phases) atmospheres (Beijing-like or Paris-like) for durations from 48h to 7 days, and compared their biological response to that of murine models exposed to a reference atmosphere. We are particularly interested by the impact of such exposures on lung physiology (in the context of health or disease such as chronic obstructive pulmonary disease or cystic fibrosis, at all life-stages), as well as muscular, cardiometabolic and digestive alterations.

Methodology and Results

We have developed a platform, named PolluRisk (Coll et al., 2018), that allows simulating for days the atmospheric phases (gases and aerosols) similar to those of cities like Paris, Beijing, etc. It is mainly resulting from the coupling of an atmospheric simulation chamber to exposure devices able to host preclinical models (isolators from Noroit® company). We also developed protocols for the exposure of murine models to the state-of-the-art urban atmospheric simulation carried out with the PolluRisk platform, in the framework of a REMEDIA test campaign (Benjdir et al., 2021). As an illustration of the results obtained we observed an increased inflammatory response in cystic fibrosis mice lungs when exposed to a simulated atmospheric environment of Paris for 48h as compared to their unexposed counterparts.

Conclusions

The first test campaigns indicate that exposure to complex urban atmospheres simulated thanks to PolluRisk platform 1. can induce respiratory effects in compromised mice (cystic fibrosis) already after 48h-72h exposure, 2. is associated with increased risk to develop lung disease at adult age, after in utero exposure for 7 days. Overall, PolluRisk platform represents an innovative and highly relevant tool for biologists interested in addressing the complex issue of Health effects resulting from air pollution.

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2HA.21

Acute Cardiopulmonary Responses to Inhaled UFPs from Cooking in Healthy Volunteers: A Controlled Clinical Study.

Motahareh Naseri, Seyedeh Mohadeseh Kazemitabar, Seyedeh Ayeh Esmaili Talesh, Abilova Aigerim Sultanbekovna, Milad Malekipirbazari, Giorgio Buonanno, Luca Stabile, Flemming Cassee, Byron Crape, Dhawal Shah, MEHDI AMOUEI TORKMAHALLEH, *University of Illinois at Chicago*

The vast majority of people spend approximately 90% of their lifetime indoors. Studies identified cooking as one of the most significant indoor particle sources which can produce high ultrafine particles (UFPs). Animal and human studies revealed the translocation of ultrafine particles to human organs such as brain, heart and lung. Inhaled UFPs may translocate to the heart through the blood circulation. This clinical study uses a novel and controlled methodology that provides new insights regarding the acute health impacts due to the exposure to cooking UFPs. Healthy volunteers (N=30) over 25 years old were recruited for this study. The volunteers resided for two consecutive days in a furnished apartment without being exposed to non-cooking sources. The first day was a control experiment (without cooking) and the second was an exposure experiment (with cooking). The volunteers' heart rate were monitored continuously by attaching a portable ECG (ARES, AthenaDiaX GmbH, and Germany) to their chests for 48 hours. Systolic blood pressure (SBP) and Diastolic blood pressure (DBP) were measured by an Omron 10 blood pressure. Particle number and mass concentrations were recorded using a NanoTracer (Philips Aerasense, Netherlands) and RizgardPlus low cost PM monitor (Rizgard Payesh Asman, LLP, Iran). A Bedfont NObreath FeNO Monitor was used to measure the lung function. Volunteers entered the apartment at 8:00 am. The SBP and DBP, and FeNO were measured in 21 steps starting one hour after arrival (9 am) and continued at (10:00 am, 10:30 a.m. , 11:00 am, 11:30 am, 12:00, 14:00, 16:00, 18:00 and 20:00). The last measurement was at 9:00 a.m. the third day (97 hours after arrival). Frying chicken drumstick and French fries in sunflower oil using a gas stove were conducted without ventilation at 9:30 am on the second day (cooking day). UFPs, particular matter, CO2, indoor temperature, RH, and oil temperatures were monitored continuously throughout the experiments. The UFP peak concentration was recorded to be approximately 5.37×105 particles/cm3.

§ Our preliminary results showed Systolic blood pressure (SBP) showed an increasing trend, with significant changes exactly after cooking. Diastolic blood pressure (DBP) experienced significant changes after cooking, one h after cooking, and 11h after cooking. No significant changes were observed for heart rate. FeNO results showed highest changes in Lung were observed exactly after cooking.

2HS.1

Defining the Discipline of Aerosol Science and its Relation to Other Scientific Disciplines: Text Analytics of Topics Making up the American Association for Aerosol Research. SARAH PETTERS, Donald Dabdub, David R. Cocker III, Andrew Grieshop, Christine McCool, Nga Lee Ng, Amy P. Sullivan, *Aarhus University*

The American Association for Aerosol Research (AAAR) annual meeting is the major forum in the United States for presenting new insight in aerosol research, addressing a broad range of societal needs using the tools and perspectives of the natural sciences, engineering, and public health. The meeting program is divided into approximately 15 topics (aerosol chemistry, aerosol exposure, aerosol physics, …, and urban aerosols). These topicals have been relatively stable in the first 40 years since the institution of AAAR. However, they overlap in scope, and their boundaries are not clearly defined. This has resulted in imbalance between the disciplines represented, and many abstracts are submitted to sessions with which they are not aligned. Here we present the results of a Task Force formed by the AAAR Board of Directors to examine this imbalance and propose a set of topics and keywords to help guide the submission of abstracts. Two decades of conference abstracts were cleaned and aggregated by topic. Topics contained 3000 to 9000 abstracts each and were decomposed by word frequency. Word spectra and lexical distance between topics were used as the basis for keywords and aim-and-scope statements. The case is made for topics with significant overlap to be reexamined with the goal of increasing the resiliency of the association and balancing its working groups. Results clarify the scope and flexibility of the groups making up AAAR, helping to define the discipline of aerosol science and illuminating it as an integral part of other scientific disciplines in the natural sciences, engineering, and public health.

2IA.1

Increased JUUL Emissions from Initial Puffs after Removing and Reinserting Pod. Eric Soule, SINAN SOUSAN, Dillon Streuber, Sarah Fresquez, Ronald Mooring, Rola Salman, Soha Talih, Jack Pender, *East Carolina University*

Standard puffing protocols are used to examine tobacco product emissions. The tobacco industry has undermined these protocols and real-world cigarette smoking can generate more emissions than generated from laboratory protocols. Electronic cigarette (ECIG) emissions from standard protocols may differ from real-world emissions, such as removing and reinserting a pod, which may underestimate emissions. This study compared JUUL emissions from four 10-puff bout procedures. Using a diaphragm pump, we generated ECIG aerosol to puff a JUUL ECIG device at a flow rate of 1.5 L/min with 3-second puffs. ECIG aerosol was captured in a 0.5 m^3 exposure chamber in four experiments. We measured $PM_{2.5}$ mass concentrations using an optical pDR-1500 reference instrument and corrected the data with a filter correction factor. The JUUL pod was removed and reinserted 0 times, 1 time, 4 times, and 9 times in experiments 1−4, respectively. Mean real-time PM2.5 concentration was 65.06 $\mu g/m^3$ (SD = 99.53) for experiment 1, 375.50 $\mu g/m^3$ (SD = 346.45) for experiment 2, 501.94 $\mu g/m^3$ (SD = 450.00) for experiment 3, and 834.69 $\mu g/m^3$ (SD = 578.34) for experiment 4. In this study, removing and reinserting a JUUL pod resulted in greater $PM_{2.5}$ concentrations compared to puffing protocols in which the JUUL pod was not removed and reinserted. ECIGs should be examined and evaluated based on ECIG users' real-world behaviors. These data have significant impacts on regulatory policy. As regulators, such as the U.S. Food and Drug Administration, evaluate the potential risks and benefits of ECIGs, they will need to utilize puffing protocols that represent the multitude of ways in which ECIGs are used in real-world settings.

2IA.2

Laboratory and Field Evaluations of the GeoAir2 Air Quality Monitor for use in Indoor Environments. Dillon Streuber, Yoo Min Park, SINAN SOUSAN, *East Carolina University*

Low-cost air pollution sensors open routes to personal exposure assessment and air monitoring in various indoor and outdoor environments. This study evaluated the accuracy of GeoAir2—a recently developed low-cost particulate matter (PM) monitor—using two types of aerosols (salt and dust), and the effect of changes in relative humidity on its measurements in laboratory settings. For the accuracy experiments, 32 units of GeoAir2 were used, and for the humidity experiments, 3 units of GeoAir2 were used, alongside the OPC-N3 low-cost sensor and MiniWRAS reference instrument. The normal distribution of slopes between the salt and dust aerosols was compared for the accuracy experiments. In addition, the performance of GeoAir2 in indoor environments was evaluated compared to the pDR-1500 reference instrument by collocating GeoAir2 and pDR-1500 at three different homes for five days. For the mass $PM_{2.5}$ concentrations for salt and dust aerosol, both GeoAir2 (r=0.96-0.99) and OPC-N3 (r=0.98-0.99) were highly correlated with the MiniWRAS reference instrument. However, GeoAir2 was less influenced by changes in humidity than OPC-N3. While GeoAir2 reported an increase in mass concentrations ranging from 100% to 137% for low and high concentrations, an increase between 181% and 425% was observed for OPC-N3. The normal distribution of the slopes for the salt was narrower than dust aerosol, which shows closer slope similarities for salt aerosols. This study also found that GeoAir2 was highly correlated with the pDR-1500 reference instrument in indoor environments (r = 0.80-0.99). These results demonstrate great potential for GeoAir2 for indoor air monitoring and exposure assessments.

2IA.3

Ionic Per- and Polyfluoroalkyl Substances (PFAS) in PM2.5 from 10 Homes in North Carolina: Insights from the Indoor PFAS Assessment Campaign. NAOMI CHANG, Clara Eichler, Daniel Amparo, Isabella Siesel, Jiaqi Zhou, Jason Surratt, Elaine Cohen Hubal, Glenn Morrison, Barbara Turpin, *UNC-Chapel Hill*

For the general population, the indoor environment is likely the main location for exposure to many per- and polyfluoroalkyl substances (PFAS); however, little is known about indoor inhalation exposures. PFAS span a wide range of volatilities and several compound classes. They are commonly found in consumer products due to their heat-, stain-, and water-resistant properties, and have been associated with adverse health effects such as hepatotoxicity, immunotoxicity, and thyroid disease. Indoor exposures are likely important because humans spend nearly 90% of their time indoors, where they use PFAS-containing products and where ventilation is limited. As part of the UNC Indoor PFAS Assessment (IPA) Campaign, 6-day integrated samples of fine particulate matter ($PM_{2.5}$) were collected at 10L/min on quartz fiber filters (QFFs) downstream of a multi-jet 2.5-µm cut point impactor at 3 occasions/home in 10 residential homes in North Carolina over a year. A second QFF was placed behind the first to assess sampling artifacts. Samples were analyzed for 27 targeted PFAS compounds with an AB SCIEX Triple Quad™ 6500 LC/MS-MS and for total organic carbon and elemental carbon with a Sunset Laboratory OC/EC Analyzer (using a second, identical sampler). Either $PM_{2.5}$ or total suspended PM was also collected over 6-days on Teflon filters and analyzed for inorganic ions with a Dionex ICS-3000 and Aquion system, enabling measurement of other major aerosol species, including an estimate of aerosol water. In addition to $PM_{2.5}$, living room windows in each home were sampled with methanol-wetted Kimwipes at 1-, 3-, 6-, and 7-9-month intervals. PFAS profiles and concentrations in $PM_{2.5}$ and on window surfaces will be discussed and compared, as will their associations with $PM_{2.5}$ properties and PFAS properties.

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.4

Indoor Ultrafine Particle Aerosol Transformation Process Considering Coagulation Effect during Emission Period. SU-GWANG JEONG, Donghyun Rim, *Pennsylvania State University*

Indoor ultrafine particles (UFP, <100 nm) are mainly originated form occupant activities, such as cooking and using consumer products. Human exposure to UFP can pose various environmental risks on human health such as DNA damage and oxidative stress. Indoor UFP exposure can significantly vary with emission source and aerosol transformation processes such as coagulation, deposition and ventilation. Such aerosol processes are affected by time-varying particle number concentration and size distribution specific to a source activity. This study investigated the particle transformation processes associated with episodic indoor source events by combining an analytical aerosol dynamic model and experimental data collected from full-scale residential buildings. The results show the size-resolved particle number concentration and geometric mean diameter (GMD) dramatically change with time for emission sources that release a number of small particles (< 20 nm). As a result, during the emission, particle number concentration increased in the form of a lognormal distribution, but the GMD also increased with time. This trend indicates that the effect of coagulation on the particle number concentration and size is significant even during the emission period. In addition, first-order equivalent coagulation loss rates were also higher at high particle number concentration (candle, gas stove), and these results show that both particle number concentration and size distribution have notable effects on coagulation dynamics during the emission period. The relative contributions of particle transformation processes (i.e., coagulation, deposition and ventilation) dynamically changes over the source emission and decay periods. Such aerosol loss mechanisms can meaningfully influence indoor particle size distribution, and accordingly human exposure to UFP in residences.

2IA.5

Aerosols Formed during Simulated Cannabis Vaping and Dabbing. XIAOCHEN TANG, Clément Gambier, Vi Rapp, Marion Russell, Lara Gundel, Hugo Destaillats, *Lawrence Berkeley National Laboratory*

Vaporizable cannabis concentrates (VCCs) consumed as a liquid (vaping) or a waxy solid (dabbing) are becoming increasingly popular. Major constituents of VCCs are semivolatile monoterpenes, sesquiterpenes and terpene alcohols, along with high molecular weight (HMW) compounds (MW > 300) that include the active cannabinoids and co-extracted plant metabolites. In addition, the HMW illicit additive vitamin E acetate (α-tocopheryl acetate) was found in many of the e-cigarettes associated with the outbreak of vaping product-associated lung injury (EVALI) in 2019 and 2020, and is considered to be a key factor associated with the disease. Despite the growing amount of research on chemical emissions from cannabis use, little is known about the influence of HMW compounds on the generation of ultrafine particles (UFPs) and thermal degradation byproducts during vaping or dabbing.

This study systematically explored how VCC formulation affects the number and mass concentration of UFPs and their chemical composition, by generating vaping aerosols from liquids of different composition under standardized conditions in a 20-m^3 environmental chamber. A mixture consisting of common terpenoids found in cannabis extracts was incrementally enriched in HMW constituents, including cannabinoids (trans-Δ9-tetrahydrocannabinol, cannabidiol and cannabinol), plant metabolites (lignans, flavonoids, triterpenes), and vitamin E acetate. Aerosol particles between 8 and 2,500 nm in size, generated by heating mixtures of various compositions, were monitored in real time with a Fast Mobility Particle Sizer spectrometer, an Optical Particle Sizer and an Aerodynamic Particle Sizer. In addition, airborne species were collected in sorbent tubes and analyzed by gas chromatography/mass spectrometry, and volatile carbonyls were sampled in dinitrophenylhydrazine-coated cartridges, extracted and analyzed by liquid chromatography. These results were used to determine the UFP yield, byproduct formation rate, and the UFP carrying capacity of HMW compounds. Users' daily intake and indoor levels of toxicants and UFPs were estimated in typical scenarios.

2IA.6

Impacts of 3D Printing and Mitigation Strategies on Particle Exposures in School Environments. QIAN ZHANG, Aika Davis, Marilyn Black, *Underwriters Laboratories Inc.*

Material extrusion 3D printers have been widely used in school environments, however, 3D printer emissions including ultrafine particles, metals and volatile organic compounds likely deteriorate indoor air quality and potentially adversely affect human health, especially for susceptible population like children. This study conducted several site monitoring at different school environments with 3D printers, aiming at understanding particle exposure levels in schools and evaluating the impacts of 3D printing emissions. Low-emitting printers with various print materials were set up in different classrooms and laboratories. Particle concentrations and size distributions in the printer room and a different room without printers (control room) were monitored to evaluate the effects of 3D printing; as well as a comparison of near the printer and away from printer to evaluate the proximity effect. Multiple exposure mitigation strategies were also evaluated for particle exposure, including opening windows, using a fume hood, using a portable air cleaner, attaching a filtration system on the printer, and applying an enclosure over the printer. The potential health impacts associated with particles will also be discussed.

2IA.7

Reducing Daily Exposure to Mobile Source Air Toxics by Improving Vehicle Cabin Air Quality. HEEJUNG JUNG, *University of California, Riverside*

The impact of air pollution on human health is a major concern and various anthropogenic sources of particulate exposure are under investigation to better understand their contributions to adverse health effects. Travel in vehicles represents a primary source of human exposure to particulate matter. A previous study estimated that for Los Angeles residents, 33-45% of daily exposure to ultrafine particles occurs while traveling in vehicles. Commuters on highways may be at particular risk, since particulate levels are demonstrably higher on highways. People living in urban areas are keen to reduce their exposure to particulate matter while riding a vehicle but there is a lack of information to make intelligent choices.

This study will show characteristic behavior of carbon monoxide, nitrogen oxides, ozone and particles in vehicle cabin in the presence of a passenger under various ventilation condition. This will give insight on how to control these pollutants in vehicle cabin.

The study will also definition a Cabin Air Quality Index (CAQI) to assess vehicle's ability to maintain clean cabin air quality similar to MPG for fuel economy. The study developed both static and dynamic test methods, which characterize and quantify vehicle cabin air quality from consumer's perspective.

The presentation will include details of the test method, results, and their implications. Standardization effort on CAQI via CEN workshop and VIAQ (Vehicle Interior Air Quality) IWG (Informal Working Group) under UNECE will be briefly explained at the end of the presentation.

2IA.8

The Use of Artificial Fogs and Indoor Air Quality. Xinyang Guo, Ya-Chun Chan, Toluwatise Ehindero, Chester Lau, RAN ZHAO, *University of Alberta*

Artificial fogs, or stage fogs, are often used by the theatrics and entertainment industries to create special visual effects. Fog droplets are generated by heating a ‘fog-juice’, typically comprised of triethylene glycol, propylene glycol, glycerol, and water. The use of fog machines is often in indoor settings, with smaller and portable types of fog machines also available for individual household use. Previous studies have implied adverse health effects associated with the inhalation of artificial fogs, particularly glycols. However, there were no systematic studies that investigated the impact of artificial fogs on indoor air quality. My team has performed two projects to 1) monitor indoor aerosol and air pollutants arising from the use of a fog machine and 2) identify harmful chemical compounds forming inside the fog juice. Experiments were performed in an unoccupied office. A number of aerosol instruments, including an optical particle counter and a scanning electrical mobility spectrometer were used to monitor the particle size. Particle-into-liquid sampler and mass spectrometry were combined to provide time-resolved chemical information. We found that the use of fog machine gave rise to elevated concentrations of aerosol in the experimental office. Aerosol evaporates within 30 min and gives rise to gas-phase species. We also found that fog juice exposed to room air contained various carbonyl species, including formaldehyde. The formation of these harmful carbonyls is likely caused by oxidants present in the indoor air. Given the low concentrations of radicals indoors, autooxidation of glycols is likely the underlying reaction mechanism.

2IA.9

Performance of Low-cost PurpleAir Sensor in Monitoring Indoor Aerosols. SHINHYE LEE, Donghyun Rim, Myoungsouk Yeo, *Architectural Engineering, Seoul National University*

Indoor aerosol concentrations can be occasionally higher than outdoors which brings attention to the importance of monitoring indoor particle concentrations. Optical light scattering low-cost monitors such as PurpleAir are being increasingly used because of short-term, real-time measurement capability at an affordable price in ordinary households. However, limited information is available for PurpleAir regarding measuring common indoor aerosols, compare to ambient air. The objective of this study is to evaluable performance and reliability of PurpleAir in aerosol monitoring in residential environments. Performances of PurpleAir and three research-grade optical particle monitors (Grimm 11-D, Aerotrak 9306, Sidepak AM520) are evaluable in a laboratory chamber and a full-scale apartment with common indoor emission sources such as incense stick burning and bacon pan frying. The results show that PurpleAir has high intra-model consistency and high linearity for mass concentrations (e.g. PM2.5) that are comparable to the research-grade sensors for all size bins, although differences in mass concentrations between the PurpleAir and other monitors are observed with concentration level. With regards to measuring number concentration (particle counts), the intra-model consistency was much lower than mass concentration, especially for particles larger than 5µm. Furthermore, the linear regression slopes between PurpleAir and research-grade monitors varied notably with the emission sources. This discrepancy between mass and number concentration measurements are likely attributed to the PurpleAir algorithm that constrains the number fraction of each size bins. These results suggest that performance of PurpleAir monitor is acceptable for monitoring mass concentrations (e.g. PM1, PM2.5, and PM10); however, measurements of number concentrations are not reliable for analyzing size-resolved indoor particle concentrations.

2IA.11

Indoor PM2.5 Concentrations in Homes and Restaurants in Ethiopia. Austin Heuer, Seblua Abebe, Nora Caballero, Margaret Hall, Ella Hein, Audrey Parrott, Alek Rabago, Diana Rodriguez, Mohammed Mehdi Shahid, Tsegaye Nega, DEBORAH GROSS, *Carleton College*

Billions of people cook using biomass fuels, globally. The consequences of using such fuels is significant for both the global climate and the health of the cooks and others who are exposed to the emissions. Introduction of both improved fuels and more efficient stoves has the potential to decrease these problems. In this study, we report measurements of the indoor air quality in home and restaurant kitchens in urban and rural Ethiopia, in real-world conditions when various stove types are in use. Stoves include those that burn wood, charcoal, biomass pellets, kerosene, or liquefied petroleum gas (LPG), as well as electric stoves. The indoor air quality is evaluated based on the real-time evolution of PM2.5 concentrations over cooking events as well as comparatively for various stove/fuel combinations. Because most cooking is done indoors, the occurrence of very high PM2.5 concentrations (>10,000 µg/m^3) under certain circumstances will also be discussed.

2IA.12

Making Aerosol Precautions for COVID-19 More Easily Accessible and Affordable to Everyone. Sathyaraj Devabhaktuni, Sonam Devabhaktuni, DEVABHAKTUNI SRIKRISHNA, *Patient Knowhow, Inc.*

Children had to return to school amidst multiple waves during the COVID-19 pandemic, often without access to aerosol safety measures, in part due to the knowledge of aerosol transmission and precautions being difficult to understand and/or costly. During the pandemic our team sought to develop scientific education and affordable solutions for reducing aerosol transmission at an elementary school. Our 9-year old team member developed a concise, scientific communication presentation on "aerosols and droplets" that was liked and shared over 3000 times around the world (https://twitter.com/sri_srikrishna/status/1501797363676975112). Air filtration in our school was improved to 5 to 8 air exchanges per hour in classrooms, eating areas, library, and auditorium using a combination of HEPA and Do-It-Yourself (DIY) air purifiers based on our peer-reviewed publication (https://www.sciencedirect.com/science/article/pii/S0048969722029813). In this poster we will explain our efforts during the pandemic to make aerosol precautions for COVID-19 more easily accessible and affordable to everyone.

2IA.14

Effect of Corona Ionizers on Indoor Air Quality and Performance of HVAC Systems. FRANCISCO ROMAY, Qisheng Ou, David Y. H. Pui, *University of Minnesota*

Corona ionizers are currently used to enhance the effectiveness of indoor air cleaners, remove odors, and more recently to inactivate viruses attached to airborne particles. However, there is limited experimental evidence of the effectiveness of ions in indoor air quality, and many commercial products have ambiguous performance statements. The purpose of this study is to perform quantitative measurements made in a real office room, with unipolar and bipolar corona ionizers. The first part of the study determines the effect of the corona generated ions on the deposition of particles to the walls of the room, on the performance of the HVAC filtration system, and of a portable indoor air cleaner. The experiments measure the mass and number concentration decay of a polydisperse NaCl aerosol as a function of time for a variety of conditions including: (1) zero ventilation in the room, (2) HVAC system (100% outdoor air) with MERV 8 and MERV 15 filtration, (3) Indoor air cleaner at different blower settings. The experiments tested a unipolar corona ionizer operated at both positive and negative polarities, and a bipolar corona ionizer. Preliminary results indicate that for the zero ventilation case, unipolar ions enhances wall particle deposition by a factor of 2, while bipolar ions do not enhance particle wall deposition. For the HVAC system and indoor air cleaners, the aerosol decay rates in the room were increased by 10 to 20%, depending on the operating conditions (air flow rate and unipolar ionizer voltage level). Ion concentrations were also measured in the room to better understand the ion distribution as a function of distance from the ion source. This work demonstrates that unipolar ions can help improve indoor air quality, particularly in poorly ventilated environments, but have a smaller effect on the performance of HVAC filtration systems and indoor air cleaners.

2PC.1

AMATI, a New Tool for Rapid Thermodynamic Calculations on Large Field Datasets. PEDRO CAMPUZANO-JOST, Donna Sueper, Simon Clegg, Benjamin A. Nault, Hongyu Guo, Jose-Luis Jimenez, *CIRES, University of Colorado, Boulder*

The hygroscopicity and acidity of ambient aerosols are key intensive properties. They have a strong impact on the physical properties of the aerosol, such as phase state and viscosity. They control the partitioning between gas- and particle-phase for inorganic nitrogen and chlorine, and also for some organic components. Importantly, both aerosol water content (LWC) and acidity (in particular, its most direct proxy, pH) influence the kinetics and thermodynamics of many heterogeneous and aqueous-phase chemical processes in the atmosphere. Hence, an accurate knowledge of these quantities is key to understanding aerosol chemical regimes in a particular region. Both LWC and pH can be measured directly with specialized instrumentation, but especially for pH such instrumentation is still not suitable for rapid field measurements. Hence, thermodynamic models (such as the Extended Aerosol Thermodynamic Model, E-AIM) have been used to predict pH and water content based on a combination of aerosol and gas measurements.

Based on our previous work using E-AIM to predict pH for a large set of aircraft missions, we have developed a general software interface for E-AIM in Igor Pro, AMATI (AMbient Aerosol Thermodynamic calculator in Igor). It simplifies performing rapid, robust LWC and pH calculations on large field datasets. It is designed to use data from the Aerodyne AMS/ACSM as the main aerosol inputs, but can easily be adapted for other particle composition sensors. It can handle a large array of gas-phase inputs for inorganic nitrogen and chloride, and can also calculate pH iteratively with fast and robust convergence if one or several of these inputs are missing. Importantly, it provides a large set of diagnostic tools to evaluate the accuracy of the model output. Examples from recent field projects are used to demonstrate the performance and potential applications of the package, with an emphasis on the free troposphere.

2PC.2

Probing the Vertical Profile of New Particle Formation and Growth in the Planetary Boundary Layer Using a Column Model with Surface- and Aircraft-Based Observations.

O'DONNELL SAMUEL, Ali Akherati, Charles He, Anna Hodshire, John Shilling, Chongai Kuang, Emma D'Ambro, Jerome Fast, Hubbe John, Michael Lawler, Ben H. Lee, Fan Mei, Siegfried Schobesberger, Stephen Springston, Joel A. Thornton, James Smith, Shantanu Jathar, Jeffrey R. Pierce, *Colorado State University*

The process of new particle formation (NPF) and subsequent particle growth is an important contributor to cloud condensation nuclei (CCN) concentrations, and CCN have important implications for climate from their impact on planetary radiative forcings. While the ubiquity and importance of NPF is generally understood, the vertical extent and many of the governing mechanisms of NPF and particle growth in the lower troposphere are uncertain. In this work, we present a two-part analysis of the vertical profile of NPF during the HI-SCALE field campaign at the Southern Great Plains observatory in Oklahoma, USA. Firstly, we analyzed airborne and ground-based observations of four NPF events. Secondly, we used a column aerosol chemistry/microphysics model along with the observations to probe the factors that influence the vertical profile of NPF and growth. From our analysis of observations, we found several instances of enhanced NPF occurring several hundred meters above the surface; however, the spatio-temporal characteristics of the observed NPF made comparisons between airborne- and ground-based observations difficult. The model was largely able to represent the observed NPF and particle growth (or lack of NPF) at the surface. The model predicted enhanced NPF rates in the upper parts of the mixed-layer, and sensitivity simulations showed that these simulated enhancements are primarily due to the temperature dependence in the NPF schemes. The simulations were sensitive to the initial vertical profile of gas-phase species provided by the measurements, such that vertical mixing in the model can either enhance or suppress NPF rates, aerosol number concentrations and particle growth rates at the surface. Finally, our model uncertainty and vertical sensitivity analysis provides insights for future field campaigns and modeling efforts investigating the vertical profile of NPF.

2PC.3

Molecular Insights into the Black Carbon Aggregation Process and Phase-mixing State in Aerosol Droplets. XIAOHAN LI, Ian Bourg, *Princeton University*

Black carbon (BC) particles have been considered the second largest anthropogenic contributor to global warming after CO2, but remain one of the largest uncertainties in current global radiative forcing estimates, partly because of the poor quantification of BC phase-mixing state (i.e., coating structure) in aerosol particles. There are three factors that govern the phase-mixing state of BC particles: (a) their oxidation degree, which is the indicator of the particle's hydrophilicity and promotes the particle distribution from the surface to the center of the droplet; (b) their surface charge, which mainly originates from the deprotonation of carboxylic groups at the edge and promotes electrostatic repulsion of BC-BC and BC-interface; (c) their relative size compared with aerosol droplets, which reflects the intensity of BC's distortion to the hydrogen bonding structure in aerosol droplets and thus the possibility of forming partly-encapsulated coating structure. However, the collective impacts of those three factors on the aggregation behavior and morphology of BC particles are poorly understood due to limitations in both experimental characterization and thermodynamic modeling. Here, we present molecular dynamics (MD) simulation results to characterize the mechanisms governing BC phase-mixing states. Specifically, we characterized BC-BC interaction in the bulk liquid phase, BC interaction with the water-air interface, and the geometric restrain of the droplet shape to the BC distribution in the droplet. Meanwhile, we constructed the configuration phase diagram of the BC coating structure as a function of BC O/C ratio, surface charge, and droplet size. Finally, we developed a BC-ensemble model, taking our configuration phase diagram as the input, to predict the light absorption properties of BC aerosols, which shows nice consistency with previous field measurements.

2PC.4

Predicted Impacts of Heterogeneous Chemical Pathways on Particulate Sulfur in Fairbanks, Alaska. SARA FARRELL, Havala Pye, Robert Gilliam, George Pouliot, Deanna Huff, Golam Sarwar, William Vizuete, Kathleen Fahey, *University of North Carolina at Chapel Hill*

Fairbanks, Alaska, is currently in serious non-attainment of the 24-hour fine particulate matter (PM2.5) National Ambient Air Quality Standard, with mass concentrations reaching over 100 ug/m3 during extreme wintertime particulate pollution episodes characterized by strong temperature inversions, low winds, and high home heating emissions. While the particulate matter composition is dominated by organic carbon and driven by primary home heating emissions, sulfate is the second-largest contributor to particle mass. Mechanisms leading to high sulfate concentrations during cold and dark conditions, when the globally dominant aqueous and gas-phase photochemical SO2 oxidation pathways are limited, remain uncertain. In addition, these conditions may also favor the formation of hydroxymethanesulfonate (HMS), an organosulfur species which is detected in certain sulfate measurements (e.g., Moch et al., 2018). While the Community Multiscale Air Quality (CMAQ) modeling system and most current chemical transport models include gas-phase oxidation of SO2 by OH and in-cloud aqueous oxidation (e.g., via H2O2 and O3) leading to sulfate, there are conditions, such as those characteristic of Fairbanks winters, where these pathways do not reproduce the high sulfate concentrations that are observed (CMAQ sulfate NMB ~ -70% for January-February 2008). Implementation of additional heterogeneous sulfur chemistry in air quality models may ameliorate this model-measurement gap. In this work we implement heterogeneous sulfate and HMS chemistry in CMAQ, version 5.3.3, and investigate the potential impacts of high ionic strength on kinetic rate expressions and model parameters. With a more complete representation of sulfur chemistry, models like CMAQ can be better equipped to link secondary aerosol concentrations to precursor levels and identify effective pathways to attain air quality goals and protect human and ecosystem health.

2PC.5

On the Role of Aerosol Morphology for the Heterogeneous Hydrolysis of N2O5. YICEN LIU, Yu Yao, Jeffrey H. Curtis, Matthew West, Nicole Riemer, *University of Illinois at Urbana-Champaign*

The heterogeneous dinitrogen pentoxide (N_2O_5) hydrolysis contributes to the nocturnal removal of NO_x. Despite major progress in the measurement of the N_2O_5 reaction coefficient (γ_{N2O5}) for ambient aerosols, it remains challenging to explain the discrepancies found between lab measurements and model parametrizations. In this study, we examined the impact of phase separation on γ_{N2O5} for core-shell and well-mixed morphologies. The stochastic particle-resolved model PartMC-MOSAIC was used to generate 100 scenarios that differ in their input parameters, including primary gas and aerosol emissions, as well as meteorological parameters. Each scenario was simulated for 48 hours with hourly output, yielding a total of 4900 populations with different aerosol compositions and mixing states. For each population, we first calculated $\gamma_{\text{core-shell}}$ based on the assumption that each particle has a core-shell structure consisting of an inorganic core and an organic coating. According to Riemer et al. (2009), $\gamma_{\text{core-shell}}$ is a function of inorganic mass concentrations and organic coating thickness. We then calculated $\gamma_{\text{well-mixed}}$ assuming that the organic and inorganic components are mixed together without considering the phase separation. The values of $\gamma_{\text{core-shell}}$ and $\gamma_{\text{well-mixed}}$ of each population were compared to quantify the effect of aerosol mixing morphology. Preliminary results show that the phase separation was significant under low NO_x conditions and was negligible under other conditions. Detailed process analysis will be presented to explain our findings.

2PC.6

Glass Transition Temperatures of Organic Mixtures from Isoprene Epoxydiol (IEPOX) Derived Secondary Organic Aerosols. BO CHEN, Jessica Mirrielees, Yuzhi Chen, Zhenfa Zhang, Avram Gold, Jason Surratt, Yue Zhang, Sarah Brooks, *Texas A&M University*

The phase states and the glass transition temperatures (T_g) of secondary organic aerosols (SOA) are important parameters for understanding their formation, growth, fate, and cloud formation properties. Previous studies have measured the T_g of pure SOA components. However, there is limited understanding of how the T_g changes with the composition of organic aerosol mixtures. Here we measured the T_g of organic binary mixtures of isoprene epoxydiol (IEPOX)-derived SOA components, including 2-methyltetrol (2-MT), 2-methyltetrol-sulfate (2-MTS), and 3-methyltetrol-sulfate (3-MTS) using broadband dielectric spectroscopy. The results demonstrate that the T_g of binary mixtures is a function of their composition and could be affected by molecular interactions between the two components. The commonly used Gordon-Taylor equation cannot accurately predict the S-shaped T_g-composition relationship of 2-MT/2-MTS and 2-MT/3-MTS mixtures. The Kwei equation, which is a modified Gordon-Taylor equation with an added quadratic term and a fitting parameter representing strong intermolecular interactions, provides a better fit in these cases. By combining Raman spectroscopy with geometric optimization simulation using density functional theory, we demonstrate that the non-linear deviation of the T_g of 2-MT/2-MTS and 2-MT/3-MTS mixtures are caused by changes in hydrogen bonding strength and number due to changes in composition.

2PC.7

Application of High Spectral Resolution Lidar (HSRL)-based Methods for Estimating PM2.5 during the KORUS-AQ Campaign. BETHANY SUTHERLAND, Nicholas Meskhidze, Sharon P. Burton, Johnathan Hair, Chris Hostetler, Richard Ferrare, *NC State University*

The amount and composition of ambient $PM_{2.5}$ has important ramifications for air quality and human health as well as climate science; therefore, much effort has been directed towards developing improved methods of remotely estimating both its concentration and chemical speciation. Here we follow up Meskhidze et al. (2021) by applying the CMAQ-HSRL-CH and HSRL-CH methodologies developed therein for estimating speciated $PM_{2.5}$ concentrations on data acquired during the Korea-United States Air Quality (KORUS-AQ) field study. The CMAQ-HSRL-CH method uses information about aerosol composition from the aerosol types derived from HSRL retrievals (Burton et al. 2012) and the CATCH algorithm (Dawson et al. 2017) and iteratively updates CMAQ model predicted concentrations. The HSRL-CH method relies solely on the HSRL retrievals and aerosol types to estimate $PM_{2.5}$ concentrations. In this study, we have updated the Meskhidze et al. (2021) HSRL-CH method to include size specific mass extinction coefficients and contribution from Rayleigh scattering following the revised IMPROVE algorithm (Pitchford et al., 2007). We also apply HSRL-based $PM_{2.5}$ data correction algorithms to GEOS-Chem model outputs, in addition to the CMAQ model. The results of our study show that over the Korean Peninsula model simulations (i.e., CMAQ and GEOS-Chem) and remotely-sensed data based algorithms show worse agreement with the ground station measurements compared to what was previously found over the eastern coast of the United States. For different methodologies, the r^2 value was reduced by roughly 50% while the normalized mean error increased by ~40%. The contributions of differing aerosol composition, complexity in the vertical structure of aerosol layers, fluctuation of mixing layer height, presence of coarse aerosols, and the effect of varying meteorological regimes on the results are investigated.

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2PC.8

Particle Turbulent Mass Flux Retrievals through Novel Remote Sensing Methodology. AJMAL RASHEEDA SATHEESH, Sabin Kasparoglu, Bethany Sutherland, Nicholas Meskhidze, Markus Petters, *NC State University*

Over the past decade, active sensors for aerosol retrievals, such as lidars and radars, have developed rapidly. These sensors can retrieve information on vertical velocity, aerosol extinction, and backscatter, and provide aerosol chemical composition-specific information at different heights above the surface. In this study, we report the application of a vertically pointing coherent Doppler Lidar (DL) and the University of Wisconsin High Spectral Resolution Lidar (UW-HSRL) for inferring aerosol vertical turbulent mass fluxes at different altitudes throughout the day. The data were collected at the DOE ARM SGP site in Oklahoma in 2020 and the TRACER campaign in La Porte, Texas, in 2022. The DL system retrieved vertical velocity and attenuated backscatter while the UW-HSRL derived profiles of aerosol backscatter, extinction, and depolarization ratio. Aerosol mass concentration at 12-m above ground was derived using aerosol number concentration and size distribution (in a range between 180 nm to 3 µm) data collected by Printed Optical Particle Spectrometer (POPS). Aerosol mass fluxes were calculated assuming that the relationship between aerosol backscatter and mass measured near ground holds for the entire planetary boundary layer. In addition to estimates of the turbulent aerosol mass flux, aerosol depolarization and lidar ratios reported by HSRL are used for inferring chemical proxies of aerosols. We anticipate that the methodology developed in this study can have several applications, including the estimations of the aerosol mass flux into the clouds.

2PC.9

Inferring Viscosity of Individual Particles from Chemical Imaging. FELIPE RIVERA-ADORNO, Jay Tomlin, Matthew Fraund, Erick Morgan, Kevin Jankowski, Mihail Laskin, Ryan Moffet, Alexander Laskin, *Purdue University*

Airborne particles alter radiative forcing of climate and have further consequences on visibility and human health. Until recently, atmospheric organic aerosol (OA) was assumed to have a liquid-like consistency. However, recent studies reported the existence of highly viscous semi-solid and even solid amorphous OA particles. Particle viscosity have an impact on the heterogeneous chemistry, gas-particle partitioning, and ice nucleation property. Variations in particle viscosity must be considered when predicting the atmospheric impact of OA. Here we use spectro-microscopy measurements of particles deposited on substrates to infer viscosity properties based on their characteristic height-to-width (H/W) ratios, as particles experience changes in morphology during collection. Standards of saccharide particles, with known viscosities, were prepared and collected by impaction on substrates. A scanning electron microscope (SEM) was then used for tilted imaging, which facilitates measurements of particle height and width. Results showed that particles with viscosities of $\geq 10^{10}$ Pa s (amorphous solids) retain their characteristic spherical morphology upon impaction and exhibit a H/W ratio of ~1. Particles with viscosities of 10^{2}-10^{9} Pa s (semi-solids) were observed as dome-shaped (H/W~0.35-0.7), which indicates partial deformation in morphology during collection. Severe flattening of particles (H/W < 0.35) became prominent at viscosities of $\leq 10^{2}$ Pa s (liquids). SEM results were correlated with quantitative X-ray spectro-microscopy measurements, demonstrating that both imaging approaches can be applied interchangeably to assess viscosity of atmospheric particles based on their dimensions after impaction. We demonstrate that chemical imaging provides practical opportunity to assess viscosity values of individual particles sampled in field studies.

2PC.10

Modeling the Effects of Aerosol Phase States on the Deposition Ice Nucleation Ability of Biogenic Secondary Organic Aerosols (SOA). ZHENLI LAI, Isabelle Steinke, Martin Wolf, Jiayun Zhao, Carolin Roesch, Xiaohong Liu, Zhenfa Zhang, Jason Surratt, Daniel Cziczo, Susannah Burrows, Yue Zhang, *Texas A&M University*

Aerosol-cloud interactions, including the formation of ice clouds, are among the largest uncertainties in predicting future climate based on the reports from Intergovernmental Panel on Climate Change (IPCC). Ice clouds are often formed through heterogeneous ice nucleation when aided by ice nucleating particles (INPs). Recent studies show that secondary organic aerosol (SOA), a major component of atmospheric fine particulate matter, may facilitate heterogeneous ice nucleation when its phase state changes from liquid to semi-solid or glass. However, few model parameterizations have been established to describe such heterogeneous ice nucleation process.

In this study, we develop a parameterization to describe the deposition ice nucleation efficiency of SOA particles for various phase states and environmental conditions. This framework takes the experimentally measured ice activation fraction and outputs the heterogeneous ice nucleation rate coefficient J_{het}, as a function of temperature, ice supersaturation, and aerosol phase state (viscosity). The simulated J_{het} isolines follow u-shaped curves in the ice supersaturation–temperature diagram, agreeing well with experimental data.

We further apply our parameterization to scenarios representative of upper troposphere (UT) aerosol to explore the importance of SOA INPs. Our simulated results suggest that certain SOA species are potentially important cirrus INP sources, and the updraft velocity of air may also alter the ice nucleation ability of SOA by affecting the cooling rate, and by extension, viscosity. Based on field measurements over the Amazon rainforest, isoprene-epoxydiol-derived SOA (IEPOX-SOA) is estimated to increase the INP number concentration by 30 L^{-1} at altitudes of 10-12 km at -46 ^{o}C and 1.1 ice supersaturation — where cirrus clouds typically form. These results imply that the interplay between INPs and aerosol phase state can be important under specific conditions and may require investigation in regional and global scale climate model to further understand the aerosol-cloud interactions and global radiative forcing.

2PC.12

The Observations of Phase Separation & Hygroscopicity in Binary Mixtures. NAHIN FERDOUSI, Kotiba A. Malek, Kanishk Gohil, Qishen Huang, Miriam Freedman, Akua Asa-Awuku, *University of Maryland, College Park*

Aerosol particles can modify the climate by influencing cloud droplets. Aqueous droplets can be composed of both inorganic salts and organic compounds of varying compositions, impacting their water uptake capabilities, also known as hygroscopicity. In this study, we investigated the hygroscopicity of inorganic salt, ammonium sulfate (AS) and organic, 2-methylglutaric acid (2-MGA), mixtures. AS/2-MGA compositions were varied by weight percentage and atomized; hygroscopicity was determined using a hygroscopicity tandem differential mobility analyzer (HTDMA),at a relative humidity of 89% ± 1.5%. Mixtures predominantly composed of AS, up to a 1:1 AS/2-MGA composition, demonstrated κ values close to pure AS at 0.57 ± 0.03. However, as solutions transitioned to being predominantly composed of 2-MGA, hygroscopicity dropped significantly. The results demonstrate non-ideal mixing and is consistent with previous studies that show phase separation behavior can occur for this binary mixture. Ammonium sulfate is prevalent on the surface of the droplet until mixtures become predominantly organic This study can help further enhance understanding of cloud-forming properties of complex aerosol mixtures containing organic and inorganic compounds including phase behaviors.

2SA.1

Issues with the OC and EC Fraction Data in Recent CSN Data.

PHILIP K. HOPKE, Yunle Chen, David Q. Rich, Judith Chow, *University of Rochester*

Since the first work in 2004, there has been use of the carbon fractions (OC1, OC2, OC3, OC4, OP, EC1, EC2, and EC3 obtained in thermal optical analysis of quartz filters using the IMPROVE protocol) to help distinguish spark-ignition vehicular emissions from those of heavy-duty diesel vehicles. It also resulting in the identification of an OP factor that includes significant contributions to sulfate and has been attributed to aged air containing SOA and secondary inorganic species. In part, EPA changed its sampling and analytical protocols in the 2007-2009 period to provide well separated individual peaks in the thermogram for such source apportionment work. However, after October 1, 2018, there was a change in the laboratory and instruments used to implement the IMPROVE_A protocol. Although this switch resulted in similar total OC and EC values, the change to an instrument that did not wait until the carbon signal returns to the baseline before starting the next temperature increment resulted in drastic shifts in the OC4 and EC2 results and caused a swap in resolved concentrations of gasoline and diesel vehicles in the resulting source apportioned PM2.5 mass values. It also affected the OP factor contributions. The only current recourse is to reanalyze those samples with an instrument designed to fully implement the IMPROVE_A protocol.

2SA.2

Impacts of COVID-19 Pandemic on Concentrations and Sources of PM2.5 and VOCs in NYC Metro Area.

MD. AYNUL BARI, Ethan Gerber, Wai Tung, Sanchita Paul, *University at Albany, SUNY*

The overarching goal of this study is to investigate the overall magnitude of the impact of COVID-19 pandemic on PM2.5 and VOC pollution in the New York City (NYC) metropolitan area. Globally, investigations have shown significant reductions of primary air pollutants such as PM2.5 and NO2 leading to notable improvement of air quality during the COVID-19 lockdown. However, O3 and secondary particulate matter have increased significantly. In the United States, NYC metropolitan area was the hardest hit early in the 2020 COVID-19 outbreak. To date, no attempt has been made in the U.S. to understand impact of COVID-19 pandemic on PM2.5 chemical composition and speciated VOCs and their resulting effects on O3 and secondary organic aerosol formation. The specific objectives are to: 1) determine the extent to which concentrations of PM2.5 components and VOC species changed during COVID-19 pandemic over the past 10 years, 2) identify and quantify the impacts of changes in anthropogenic activities during COVID-19 pandemic to air quality in relation to long-term trends. We examined changes in PM2.5 components and VOC species over the last decade (2011–2020) in three different time periods i.e., 1) pre-lockdown, 2) lockdown, and 3) reopening phase. To identify and quantify changes in PM2.5 and VOC sources during COVID-19 pandemic and their long-term trends in source contributions, we applied positive matrix factorization (PMF) for 2011–2020 using available data in the NYC metro area and non-parametric trend analysis. The changes in O3 and secondary organic aerosol formation during the COVID-19 pandemic were also investigated. Findings can improve our understanding of overall magnitude and impacts of COVID-19 pandemic on air quality and urban chemistry, which is important for the broader scientific community and general public.

2SA.3

Characterization of PM2.5 and PM10 near California Highways with a Focus on Non-Tailpipe Emissions. XIAOLIANG WANG, Steven Gronstal, Brenda Lopez, Heejung Jung, L.W. Antony Chen, Steven Sai Hang Ho, Judith Chow, John Watson, Chas Frederickson, David Mendez-Jimenez, Tianyi Ma, Ling Cobb, Qi Yao, Seungju Yoon, *Desert Research Institute*

This study evaluates the contributions of different sources, particularly vehicle non-tailpipe emissions, to particulate matter (PM) in near-road environments. $PM_{2.5}$ and PM_{10} filter samples were collected near I-5 and I-710 in California over two weeks. Each sample was characterized for inorganic and organic species. The effective variance chemical mass balance (EV-CMB) model apportioned PM concentrations to different sources.

Average concentrations of $PM_{2.5}$ and PM_{10} were 10-15 and ~30 $\mu g/m^3$, respectively. For $PM_{2.5}$, the most abundant components were: organic matter (OM; ~30–40%), mineral dust (~25–30%), and elemental carbon (EC; ~10–15%). For PM_{10}, mineral dust (~40–45%), OM (~25%), nitrate (~6-11%), and EC (6-8%) were the dominant component. EC concentrations near I-710 were 19-26% higher than those near I-5, likely due to more diesel vehicles on I-710. Average particulate PAH concentrations near I-710 were 47% higher than those near I-5, particularly for lower molecular weight PAHs. High correlations were found for elements with common sources, such as markers for brake wear and road dust.

Source apportionment shows that road dust was the largest near road PM source and it contributed more to PM_{10} than to $PM_{2.5}$. On average, contributions of the non-tailpipe fractions (brake and tire wear) to $PM_{2.5}$ exceeded those of tailpipe fractions (diesel and gasoline emissions) at I-5 (~30% vs. 20%) while they were comparable at I-710 (15–17% vs. 15–19%). For PM_{10}, the non-tailpipe contributions were 2 – 3 times the tailpipe contributions. Brake wear particles were more abundant than tire wear particles, though there was a higher uncertainty in the tire wear contribution estimates. The I-710 samples found brake wear with a higher copper content than that found in I-5 samples, reflecting different fleet compositions.

2SA.4

Biomass Burning Emissions Are a Main Driver of the PM2.5 Pollution Problem in the San Joaquin Valley of California. JUSTIN TROUSDELL, Lijuan Li, Keming Pan, Qi Zhang, *University of California, Davis*

Fresno and other cities within the San Joaquin Valley face persistent air quality challenges like compliance with the 24-hr avg. national ambient air quality standard (NAAQS) for PM2.5. To investigate sources of PM2.5 to Fresno, non-refractory PM2.5 (NRPM2.5) data were collected at 10 min time resolution at the California Air Resources Board (CARB) Garland, Fresno air quality monitoring site between 10/16/2018 and 02/11/21 with a Time-of-Flight Aerosol Chemical Speciation Monitor (TOF-ACSM) equipped with a capture vaporizer (CV) and a PM2.5 lens. Previous studies have reported significant contributions from biomass burning organic aerosol (BBOA) in winter from residential wood burning (RWB) and increased size and frequency of wildfires (WF) in recent history. Furthermore, BBOA from prescribed burns (Rx) including agricultural burns may represent an as of yet underrated contribution. Therefore we performed source apportionment using a 4-day rolling window with a 6-hour timestep on the 26-month ToF-ACSM dataset within the ME-2 Source Finder (SoFi) software to investigate BB impacts on NRPM2.5. We estimated the background level for the fraction of ion signal at m/z 60(*f*60), a typical BB tracer, to be 0.06% for the capture vaporizer (CV) and found the measured *f*60 to be above background ~ 80% of the measurement period suggesting frequent BB influences. Periods of BB influence are categorized into one of the three BB types; WF, RWB, and Rx on a day-to-day basis using seasonality, CARB records of Rx burning permissions, backtrajectories and satellite products. Data segregation by BB type reveals characteristic differences in PM composition and loadings, diurnal behavior, and seasonality depending on the dominant BB type. Total BBOA contributes on average to NRPM2.5 loadings 29% during WF event days, 15% RWB, and 19% Rx. Additionally, a 12-day period of extremely poor air quality during the Camp Fire in November 2018 exacerbated by a regional, low-dispersion episode is investigated in more detail. Total BBOA represented ~ 55% of NRPM2.5 during this period.

2SA.5

Transport and Transformation of Atmospheric Aerosol across Central Europe with Emphasis on Anthropogenic Sources (TRACE). SHUBHI ARORA, *Leibniz Institute of Tropospheric Research*

The trend in PM10 concentrations in Europe has stagnated over the last two decades, showing only limited annual changes even though there are continued reductions in PM emissions. Possible reasons could be linked to both the aging processes of the particles in the atmosphere and their long-range transport. Therefore, a better understanding of the multiple origins of the atmospheric aerosol requires their sources apportionment at different places for the development of efficient mitigation strategies. The ultimate objective of the current Czech-German bilateral project TRACE is to assess the transport and transformation of atmospheric aerosol across Central Europe with emphasis on anthropogenic sources (including coal and wood combustion) using synergic measurement methods (offline and online) and state-of-the art modelling tools including receptor-oriented models and chemical transport models. Measurements were performed during winter and summer periods in 2021 simultaneously at three sampling places (Melpitz, DE, Kosetice, CZ, and Frydland, CZ) using state-of-the-art online and offline comprehensive chemical characterization of the atmospheric aerosol. Preliminary results from SMPS showed peaks at 35 µg/m³ mass concentration. Moreover, results from Aerosol Mass Spectrometer and receptor modeling via Positive Matrix Factorization (PMF) from the winter campaign 2021 will be presented.

2SA.6

Source Apportionment of PM2.5 in Ambient Concentration in Lahore, Pakistan. WAJIH UR REHMAN, *COMSATS University Islamabad*

A source apportionment study using Chemical Mass Balance (CMB) has been carried out to improve upon the results of a previous study. The earlier study used Positive Matrix Factorization (PMF) for source apportionment for a receptor location in Lahore, Pakistan. It has been found that great improvement in source apportionment results are obtained if our method is used for the same data as provided in previous literature. We were able to classify more sources and provide more meaningful and realistic results and characterize more components of air pollutants nuisance to the public in Lahore, Pakistan.

In our study, we were able to characterize 7 distinct sources of interest to air pollution controls (as opposed to only 5 in previous study). Additionally, diurnal variation in data was also observed as Day, Evening and Night time source apportionment results, which were not explored in previous study.

2SA.7

Source Apportionment of Fine Aerosols (PM2.5) with a Bayesian Mixing Model for Major Sources over the Northeast Asia.

JOOSUNG OH, Kyung Hwan Kim, Gwi-Nam Bae, *Korea Institute of Science and Technology (KIST)*

Northeast Asia is heavily affected by fine aerosols ($PM_{2.5}$) due to various factors such as rapid economic growth, high population density, geopolitical location, and seasonal wind direction. We investigated to analyze the influence of pollutants, contribution of pollutants through $PM_{2.5}$ analysis at three sites (Beijing, Seoul, Toyama) in Northeast Asia. $PM_{2.5}$ samples had been collected seasonally at each site for 3 weeks. And we measured mass concentration, chemical composition, elemental composition and the stable isotope ratios (SIR) in these $PM_{2.5}$ samples. C, N, S SIR ($\delta^{13}C$, $\delta^{15}N$, $\delta^{34}S$) analyzed at each point was similar or different depending on the season and wind direction. As a result, when Seoul and Beijing have similar backward trajectory analysis results (HYSPLIT) in autumn and winter, the $\delta^{13}C$ of two sites have a very significant correlation ($p<0.01$). The nitrogen stable isotope ratio showed a statistically significant correlation ($p<0.05$) in autumn and winter in Seoul and Beijing. In terms of sulfur isotope ratio, which is highly affected by coal-fired power plants, there was a significant correlation ($p<0.05$) in Beijing and Seoul in winter. Toyama was not statistically significant with Beijing and Seoul regardless of the season. A Bayesian isotopic mixing model (Stable isotope analysis in R (SIAR)) was applied to estimation the major sources in each site. The results indicates that Coal-fired fire plant, coal combustion, vehicle emission, biomass burning are main sources of $PM_{2.5}$. According to the SIAR model results, both Beijing and Seoul show an increase in the effects of coal-fired power plants and coal combustion in winter (54.2% in Beijing, 46.7% in Seoul). The next highest contribution rate was vehicle emissions (7.3% in Beijing, 11.5% in Seoul). In particular, $PM_{2.5}$ in Seoul showed a high tendency in all seasons to contribute to vehicle emissions.

2SA.8

Source Apportionment of PM2.5 in Seoul, South Korea and Beijing, China Using Dispersion Normalized PMF.

JIEUN PARK, Hyewon Kim, Youngkwon Kim, Jongbae Heo, Sang-Woo Kim, Kwon Ho Jeon, Seung-Muk Yi, Philip K. Hopke, *Harvard University*

East Asian countries experience severe air pollution owing to their rapid development and urbanization induced by substantial economic activities. South Korea and China are among the most polluted East Asian countries with high mass concentrations of $PM_{2.5}$. Although the occurrence of transboundary air pollution among neighboring countries has been recognized for a long time, studies involving simultaneous ground-based $PM_{2.5}$ monitoring and source apportionment in South Korea and China have not been conducted to date. This study performed simultaneous daily ground-based monitoring of $PM_{2.5}$ in Seoul and Beijing from January to December 2019. The mass concentrations of $PM_{2.5}$ and its major chemical components were analyzed simultaneously during 2019. Positive matrix factorization (PMF) as well as dispersion normalized PMF (DN-PMF) were utilized for the source apportionment of ambient $PM_{2.5}$ at the two sites. 23 h average ventilation coefficients were applied for daily $PM_{2.5}$ chemical constituents' data. Nine sources were identified at both sites. While secondary nitrate, secondary sulfate, mobile, oil combustion, biomass burning, soil, and aged sea salt were commonly found at both sites, industry/coal combustion and incinerator were identified only at Seoul and incinerator/industry and coal combustion were identified only at Beijing. Reduction of the meteorological influences were found in DN-PMF compare to C-PMF but the effects of DN on mobile source were reduced by averaging over the 23 h sampling period. The DN-PMF results showed that Secondary nitrate (Seoul: 25.5%; Beijing: 31.7%) and secondary sulfate (Seoul: 20.5%; Beijing: 17.6%) were most dominant contributors to $PM_{2.5}$ at both sites. Decreasing secondary sulfate contributions and increasing secondary nitrate contributions were observed at both sites.

2SA.9

Source Apportionment of PM2.5 using Dispersion Normalized Positive Matrix Factorization (DN-PMF) at Beijing and Baoding in China. ILHAN RYOO, Jieun Park, Taeyeon Kim, Jiwon Ryu, Yeonseung Cheong, Hyewon Park, Kwon Ho Jeon, Jae-Hyun Lim, Seung-Muk Yi, Sang-Rin Lee, *Seoul National University*

PM2.5 refers to particulate matter with an aerodynamic diameter of 2.5 µm or less, and is an air pollutant designated as a carcinogen by the WHO in 2013. Recently, economy in China has been rapidly growing with expanding industries which led to the poor air quality, especially the PM2.5 mass concentrations.

In China, the Action Plan for Air Pollution Control was implemented from 2013 to 2017 to reduce air pollutants and achieved its goal. However, PM2.5 high concentrations events are still occurring. Simultaneous ground-based monitoring of PM2.5 in multiple cities in Northeastern China is needed in order to confirm air quality after air pollution reduction efforts. Therefore, in this study, we conducted PM2.5 sampling in Beijing and Baoding for source apportionment and to derive potential contaminated areas.

Sampling was conducted using a three-channel low-volume air sampler in Beijing (2017.06.21 ~ 2019.12.17) and Baoding (2018.04.09 ~ 2019.08.24).

The samples were analyzed for trace elements (21 species, Al, Si, S, Cl, etc.), carbonaceous species (Organic Carbon, Elemental Carbon), and ionic species (6 species, SO42-, NO3-, etc.). PM2.5 mass concentration and its chemical composition were applied to DN-PMF (Dispersion Normalized Positive Matrix Factorization) for source apportionment. DN-PMF calibrate the weather effect with the ventilation coefficient calculated by Mixing Layer Height by the wind speed. Subsequently, directional analysis of PM2.5 sources was performed by CBPF (Conditional Bivariate Probability Function). And a back trajectory analysis was performed using the HYSPLIT4 (Hybrid Single-Particle Lagrangian Integrated Trajectory 4), and the PSCF (Potential Source Contribution Function) was performed to analyze potential pollutant regions using back trajectory results. Furthermore, the Joint-PSCF was carried out by combining the results of the PSCF to create a commonly contaminated area in the two cities.

Our results can be used as basic data to prepare future PM2.5 reduction measures and management strategies.

2SA.10

Real-time Analysis and Clustering of Single-particle Mass Spectrometer Data. Paul Haubenwallner, Ellen-Iva Rosewig, Robert Irsig, Johannes Passig, Sven Ehlert, Andreas Walte, RALF ZIMMERMANN, *Rostock University and Photonion GmbH*

Single-particle mass spectrometer (SPMS) contributed substantially to our understanding of aerosols and atmospheric processes (Pratt and Prather, 2012). They are unique for their capabilities to address the particle’s mixing state and for their chemical coverage with e.g. metals (Passig et al. 2020) and polycyclic aromatic hydrocarbons (Passig et al. 2022). SPMS are real-time instruments, however, the complex data evaluation is performed after the measurements (Sultana et al., 2017), which disables on-line screening of hazardous particles and real-time risk assessment.

We are developing a real-time software for SPMS data including data acquisation, preprocessing, screening and clustering. The toolkit is designed to fully analyse many particles per second, which requires non-standard C++ code, integrable in other environments. The analysis begins with acquisation and conversion of raw data from the two time-of-flight mass analyzers into nominal data. Of note, the laser desorption/ionization in SPMS challenges the instrument’s dynamic range with both smallest signals from trace compounds and high ion currents causing detector saturation. The resulting baseline instabilities and detector ringing need to be corrected to prevent data misinterpretation. The much smaller nominal data is ready for chemical characterization. This is typically based on clustering algorithms, creating groups of particles, that share their chemical properties. We integrate the widespread ART2a (Gross, et al. 2010), continuously extending and re-organizing the cluster results and thus featuring the first real-time ART2a clustering in SPMS. Finally, we show fast real-time screening of SPMS mass spectra for safety-relevant particles and database matching.

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2SA.12

Air Quality and Profile of Inorganic Composition of PM2.5 and Source Apportionment in Karachi, Pakistan. FATIM SANNOH, Zafar Fatmi, David Carpenter, Azhar Siddique, Kamran Khan, Jahan Zeb, Muhayatun Santoso, Mirza M. Hussain, Haider Khwaja, *University at Albany*

Use of fossil fuel impact the air quality. Air pollution is a public health issue in many developed and developing countries. Exposure to ambient particulate matter ($PM_{2.5}$) has been associated with an increase of various diseases as far as an excess of mortality. In Pakistan, air pollution accounts for a reduced life expectancy by 60 months but air pollution continues to be a threat to public health. Numerous studies have shown increased morbidity and mortality of COPD, lung cancer, and asthma with long term exposure to fine particulate matter, but effects of short-term exposure to $PM_{2.5}$ needs to be better assessed in Karachi, Pakistan. The air quality studies in suburban cities of developing countries of Asia needs to be investigated further. We used a time-series analysis to examine the air quality in two cities in Karachi, Pakistan over a period of four seasons. Analysis of samples for anions and cations was performed.

A meteorological data and $PM_{2.5}$ concentrations over the sampling periods to assess the air quality index. Pearson correlation and Enrichment factor analysis was utilized to identify heavy metals, and backward trajectories to investigate local and long-range emission. Positive matrix factorization (PMF) to measure source apportionment. We examined the risk assessment from short term PM exposure. Based on the time-series $PM_{2.5}$ concentrations were higher in winter and summer having the lowest pollutant concentrations. BC levels exceeded the mean concentrations of each cycle. Metal analysis showed an influx of metal ions emitted from anthropogenic and natural sources at both sampling sites. Analysis for anions showed consistent elevated levels of sulfate, chloride, and oxalate. And cations analysis had high Ca, Na, and K. Presence of NH_4 was observed. Our results indicate fossil fuel combustion, vehicular emission, and sea salt and dust particles as the primary source of $PM_{2.5}$ and its constituents. Exposure to $PM_{2.5}$ has shown to influence oxidative stress, pulmonary inflammation, and several severe cardiac events. The $PM_{2.5}$ forms a major portion of the overall particulate air pollution in Pakistan. We monitored the daily levels of $PM_{2.5}$ and determined the poor air quality associated with extremely high concentrations of $PM_{2.5}$, black carbon (BC), metals, and ionic species. This could set in motion implementation of possible emission control strategies by policy makers that might influence air quality standards in Pakistan.

2SA.13

Developing and Testing Machine Learning Algorithms to Process SEM-EDX Images. BORIS GALVIS, Natali Zambrano, David Restrepo, Olga Lucia Quintero Montoya, Nestor Rojas, Elena Montilla Rosero, Jose Duque, *Universidad de La Salle*

In this work, we developed machine learning models to analyze the results SEM (Scanning Electron Microscope)-EDX (Energy Dispersive X-Ray Spectometry) technique of individual particles to later relate their morphological and chemical characteristics. Five models were developed with a database of 466 NASA Cosmic Dust Catalog Vol 15 (1997) images, classified into four groups: Cosmic (C), Artificial Terrestrial Contamination (TCA), Natural Terrestrial Contamination (TCN) and Aluminum or Aluminum Oxide Sphere (AOS) in order to identify which model best fit the cosmic dust images. We are also performing individual particle analysis with the digital image processing program ImageJ (developed at the National Institutes of Health) in order to obtain morphological characteristics sucha as area, perimeter, aspecto ratio, circularity and solidity. The results show that the optimal model was the one developed by transfer-learnig with the pre-trained model "efficientnetv2-b1". In the future, we intend to use the developed machine learning code to characterize SEM/EDS results from coarse particulate matter sampling in the cities of Bogota, Cali and Medellin, Colombia.

2UA.2

Organic and Elemental Carbon in the Urban Background in an Eastern Mediterranean City. Tareq Hussein, Xinyang Li, ZAID BAKRI, Andrés Alastuey, Sharif Arar, Afnan Al-Hunaiti, Mar Viana, Tuukka Petäjä, *Michigan Technological University*

The Mediterranean region is an important area for air pollution as it is the crossroads between three continents; therefore, the concentrations of atmospheric aerosol particles are influenced by emissions from Africa, Asia, and Europe. Here we concentrate on an eleven-month time series of the ambient concentration of organic carbon (OC) and elemental carbon (EC) between May 2018–March 2019 in Amman, Jordan. Such a dataset is unique in Jordan. The results show that the OC and EC annual mean concentrations in $PM_{2.5}$ samples were 5.9 ± 2.8 μg m^{-3} and 1.7 ± 1.1 μg m^{-3}, respectively. It was found that the majority of OC and EC concentrations were within the fine particle fraction ($PM_{2.5}$). During sand and dust storm (SDS) episodes OC and EC concentrations were higher than the annual means; the mean values during these periods were about 9.6 ± 3.5 μg m^{-3} and 2.5 ± 1.2 μg m^{-3} in the $PM_{2.5}$ samples. Based on this, the SDS episodes were identified to be responsible for an increased carbonaceous aerosol content as well as $PM_{2.5}$ and PM_{10} content, which may have direct implications on human health. This study encourages us to perform more extensive measurements during a longer time period and to include an advanced chemical and physical characterization for urban aerosols in the urban atmosphere of Amman, which can be representative of other urban areas in the region.

2UA.4

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

Secondary aerosol has impacts on health, air quality, and climate. It is formed through various gas-to-particle processes and can be produced from gases emitted from biogenic, anthropogenic, and biomass burning sources upon atmospheric oxidation. The formation, sources, and sensitivity to changing gas precursors need to be better understood. Most studies of the formation and properties of secondary aerosol use traditional Teflon environmental chambers in which one or more precursors are injected and oxidized and the resulting aerosol is measured. Here, we summarize observations made using a complementary approach, for which a pair of 2-cubic meter portable chambers are operated with entirely or mostly ambient air at the location of interest. The Captive Aerosol Growth and Evolution (CAGE) chambers were used during a pair of field studies in Riverside, CA, with the first in spring, 2022, and the second in late summer/early fall, 2022. The two identical CAGE chambers were utilized to measure the sensitivity of secondary aerosol concentration and composition to changing precursor gas concentrations by operating one chamber as a reference chamber in which the gas composition mirrored that of ambient air just outside and the second as a perturbation chamber through the controlled addition of a fixed concentration of NOx, VOCs, or NH3. Monodisperse seed particles were intermittently injected into both chambers and the composition and volume concentration of the secondary aerosol formed on them were quantified using mini aerosol mass spectrometer (mAMS) and a scanning mobility particle sizer (SMPS), respectively. Together with simultaneously measured trace gas concentrations, the measurement of secondary aerosol in the chambers is used to investigate the responsible species and mechanisms.

2UA.5

Tropical Air Chemistry in Lagos, Nigeria. Abedola Odu-Onikosi, Pierre Herckes, Matthew Fraser, PHILIP K. HOPKE, John Ondov, Paul Solomon, Olalekan Popoola, George Hidy, *EnvironQuest*

The Nigerian city of Lagos experiences atmospheric photochemistry and aerosol chemistry as a consequence of severe air pollution. A study covering a year between August 2020 and July 2021 included measurements of gas-phase and aerosol processes, with surface meteorology at six urban sites. The sites were selected to represent near sea coast conditions inland towards the agricultural and grasslands of Nigeria. The observations included continuous concentrations for CO, SO2, NOx, VOC, O3, PM2.5 and PM10. Samples were collected and analyzed for speciated VOC, and particulate chemical composition including inorganics and organics. The average diel variations in concentrations indicated well-known local photochemistry resulting from the presence of combustion sources, including motor vehicles, petroleum production and use, and open burning. The annual diel characteristics were emission dependent and modulated by meteorological variability, including the sea breeze and the seasonal changes associated with monsoon and Harmattan winds. Gases and particulate matter varied daily with the onset of source activities during the day. For fine particles less than 2.5 micrometers in diameter (PM2.5), source emissions into the air included those affected by the photochemical cycle. Importantly, particle sources included a large component of dust and carbonaceous material. For the latter, there was evidence that particle concentrations were dominated by primary sources, with little secondary material formed in the atmosphere. From complementary studies, there were occasions when regional chemical processes affected the local conditions, including transportation, industry, commercial activity and open waste burning.

2UA.6

Characteristics of Haze Episodes during Winter in Seoul, Korea 2021 Using an Aerosol Mass Spectrometer. KYUNG HWAN KIM, Su-Yeon Choi, Junwon Ko, Myeong Ha Lee, Hyoun Cher Jin, Seung-Bok Lee, Jin-young Kim, Gwi-Nam Bae, *Korea Institute of Science and Technology*

We investigated three haze episodes out of five episodes occurred in the Seoul Metropolitan Area (SMA) during December in 2021 to understand how the haze in the SMA occurs and it ends. Both gaseous and particulate matters were measured using on-line instruments system. For the particulate matters, an aerosol mass spectrometer (AMS) was used to see the temporal variations of organic and inorganic components in PM1.0. Among the three episodes, EP1 displayed the highest PM1.0 concentrations reaching almost 80 µg/m3 in PM1.0. On the other hands, EP2 and 3 showed relatively moderate increase reaching 40 to 50 µg/m3 in PM1.0. Interestingly, EP2 and 3 exhibited quite different organic and inorganic compounds increase and decrease tendency reflecting the main trigger of the haze occurrence might be different in the two episodes. The consecutive haze days during EP1 and 2 were ended up by both rainout (4 to 7 mm) and northerly wind with high wind speeds (>5 m/s) while EP3 was only ended up by northerly wind with high wind speeds. In fact, 1 to 2 mm of precipitation may contribute to the elevated inorganic compounds such as nitrate, sulfate, ammonium, and chloride by increasing R.H. reaching almost 100% whereas the organic components were not increased as much as inorganic components were in EP3. In summary, meteorological parameters are the crucial factors to make and end up the haze episodes in SMA during December in 2021.

2UA.7

Measuring the Impacts of Bus Electrification Using a Low-Cost Sensor Network in Chicago, IL. JONATHAN LIU, Scott Counts, Madeleine Daepp, *University of California, Los Angeles*

In this project, we use a network of low-cost air sensors to compare the local air quality impacts of bus fleet electrification. In recent years, major metropolitan areas have been steadily reducing the environmental impacts of bus fleets, a major source of noise and air pollution, by introducing alternative fuel types and engine systems, the latter including hybrid-electric ICE buses and all-electric buses. While hybrid-electric buses and all-electric reduce and eliminate tailpipe emissions, respectively, less is known about how electrification affects non-exhaust particulate matter (PM) emissions, including brake and tire wear. Project Eclipse is a hyperlocal environmental sensing platform which includes custom designed internet-connected low-cost air quality sensors armed with PM2.5, NO2, CO, SO2, and O3 sensors. This project uses (1) real-time air quality data from a network of over 100 air sensors primarily installed at urban bus stops combined and (2) public transit data from the Chicago Department of Transportation to better understand the local air quality impacts of buses. In this study, we compare how local concentrations of NO2, a tailpipe tracer, and PM2.5, emitted through both exhaust and non-exhaust emissions, change during bus arrival and departure. Using bus fleet data, we compare how the ratio of NO2 to PM2.5 differs between bus type across the city of Chicago.

2UA.8

2-Dimensional Model of SOA Formation from the Photooxidation of Linear Alkanes Using Volatility and Reactivity. AZAD MADHU, Myoseon Jang, David Deacon, *University of Florida*

Alkanes are a significant component of emissions from diesel fuel and they must be considered when predicting secondary organic aerosol (SOA) formation in urban environments. In this study, SOA formation is predicted using the Unified Partitioning Aerosol Phase Reaction (UNIPAR) model via the multiphase reactions of various linear alkanes. The model used explicit gas kinetic mechanisms (Master Chemical Mechanism v3.3.1, MCM) of linear alkanes, with autoxidation pathways of alkoxy radical species added, to predict the formation of oxidized products. The resulting oxidized products from the gas mechanism were lumped into an array based on their volatility and reactivity. This product distribution was used to predict the formation of SOA with the three major pathways used by the UNIPAR model: gas-particle partitioning, organic phase oligomerization, and acid catalyzed oligomerization and organosulfate formation in the inorganic phase. Autoxidation reactions served to increase the production of low volatility compounds in the gas phase which consequently increased partitioning to the particle-phase. The model predictions are compared to data collected from an outdoor photochemical smog chamber for linear alkanes C9-C15 under varying environmental conditions (NO_x levels, temperature, and inorganic seed conditions). Because MCM does not currently have explicit gas kinetic mechanisms for linear alkanes larger than C12, the shift in volatility between product distributions for alkanes C9-C12 was mathematically characterized as a function of carbon number using an incremental volatility coefficient. This incremental volatility coefficient was used to predict product distribution of alkanes C13-C15 which were subsequently used to predict SOA formation and compared to chamber data. Further extrapolation was performed to predict the possible SOA formation of larger linear alkanes (>C15) that can be found in diesel. Alkane SOA was found to be insignificantly impacted by particle-phase reactions but significantly impacted by gas-particle partitioning.

2UA.9

Modeling Peroxy Radical (RO2) Fate and Secondary Organic Aerosol Formation during α-Pinene Perturbation Experiments. JEAN RIVERA-RIOS, Masayuki Takeuchi, Havala Pye, Nga Lee Ng, *Georgia Institute of Technology*

α-pinene is one of the most studied monoterpenes in atmospheric chemistry. Despite years of work, the contribution of α-pinene to ambient aerosol and the sensitivity of secondary organic aerosol (SOA) formation to ambient conditions remains to be fully understood. In this work, we utilize ambient perturbation experiments to understand the formation of SOA from α-pinene oxidation under real urban conditions. Ambient perturbation experiments are chamber experiments that use ambient air as the matrix and thus can have a wide variety of oxidation conditions. An outdoor chamber is filled with ambient air and perturbed with a fixed amount of α-pinene. We then monitor the oxidation products and SOA formation using aerosol mass spectrometer (HR-ToF-AMS) and FIGAERO high-resolution time-of-flight chemical-ionization mass spectrometer (HR-ToF-CIMS). These experiments are modeled using the Master Chemical Mechanism (MCM) as well as recently published and updated SOA formation mechanisms, that include among other changes, isomerization reactions. We find that the aerosol yield depends on the peroxy radical (RO_2) fate, decreasing as RO_2+NO becomes the dominant pathway. In addition, isomerizations are necessary to model the observed aerosol formation. The isomerization rates required to explain the observed SOA yields during perturbation experiments are compared to standard, high NO_X, laboratory chamber experiments. We find that the isomerization rates required to model the measured SOA during perturbation experiments are much slower than those needed to explain SOA yields from standard laboratory chamber experiments with high NO_X conditions. The observed SOA yields in the perturbation experiments are sensitive to relatively low nitrogen oxide concentrations, which implies that aerosol formation under high NO_X laboratory chamber conditions is likely due to mechanisms different from isomerization reactions. The data and mechanism updates used in this work provide new insights for improved representation of α-pinene SOA formation in global and regional models.

2UA.10

Continuous Particle Number Concentration Determination of Ambient Air in Measurement Networks. Markus Pesch, Friedhelm Schneider, Torsten Bayer, Michael Schüler, Katharina Roloff, GERHARD STEINER, *Grimm Aerosol Technik Ainring*

Recently WHO published new Global Air Quality Guidelines (WHO, 2021), once more stressing the danger of air pollution on human health, and addressing this, for the first time, also to the number of ultrafine particles (UFP, particles < 0.1µm) in the ambient air. No definitive air quality guidelines are expressed for UFP yet, however, WHO highlights best practices and the importance of the continuous measurement of ultrafine particles.

Furthermore, the European CEN/TS 16976:2016 guideline expands the need to measure ultrafine particles in the ambient air also to address the impact of UFP on the global climate. This guideline also underlines the need to determine the particle number (PN) of the ambient aerosol to supplement commonly applied measurement procedures of determining particulate mass fractions such as PM10 or PM2.5, as mass is not a feasible metric for ultrafine aerosols.

This CEN/TS aims to harmonize currently available measurement techniques for the determination of the particle number concentration in the ambient air, thereby defining instrument performance characteristics such as overall instrument counting efficiency, D50/D90 diameters and specifying the range of measurement uncertainties in instrument calibrations.

Here, we are reporting preliminary results of two 1-month measurement campaigns in Halle (Saale), Germany and Berlin, Germany, carried out in collaboration with the authorities operating the local air quality monitoring networks. In both measurement campaigns, instruments were deployed at existing measurement stations close to heavily frequented streets and at rather remote background locations and operated with high temporal resolution.

For the determination of the particle number of ultrafine aerosols, we were using the GRIMM condensation particle counters EDM 465 and CPC 5421, specifically designed for 24/7 use and mounted in dedicated weatherproof and climate controlled outdoor shelters. Both instrument models were calibrated in accordance to CEN/TS 16976:2016 and were using sample collecting probes with integrated membrane dryers. In addition to the UFP measurements, PM10 and PM2.5 values were determined with GRIMM EDM 180 optical aerosol spectrometers.

We will give details on the used measurement instruments, describe the measurement sites, and will give an outlook on possible data analysis using GRIMM aerosol monitors for long term measurements.

Acknowledgement:
We would like to thank the Senate Department for the Environment, Urban Mobility, Consumer Protection and Climate Action of the City of Berlin for their collaboration and the access to their measurement sites within the Berlin air quality network BLUME.

2UA.11

Chemical Characterization of Ambient Aerosol during the 2022 ACROSS Campaign at the Urban Paris Site.

Sydney Riley, DREW PRONOVOST, Lelia Hawkins, Ludovico Di Antonio, Astrid Beauville, Antonin Bergé, Mathieu Cazaunau, Pascale Chelin, Servanne Chevaillier, Anaïs Féron, Frank Maisonneuve, Christopher Cantrell, Vincent Michoud, Claudia Di Biago, Aline Gratien, *Harvey Mudd College*

The Atmospheric Chemistry of the Suburban Forest (ACROSS) campaign focused on atmospheric composition and transformation of interacting biogenic and anthropogenic emissions. The campaign spanned 13 June to 26 July 2022 at three sites: the urban University of Paris Rive Gauche (PRG), the remote forest Rambouillet, and an aircraft that sampled throughout the region. A large suite of instrumentation at each site provided a comprehensive perspective of 2022 summertime chemistry. This poster will focus on aerosol composition and key gas phase components measured at the PRG site. The ACROSS campaign included periods of excessive heat and cooler periods, with weather more typical of European summer. During hot periods, winds were more likely to transport urban air masses toward the forest. An Aerodyne time-of-flight aerosol chemical speciation monitor (ToF-ACSM) was used to study non-refractory PM_1 chemical composition. Gases were measured with a chemiluminescence NO_x analyzer, an UV photometric ozone analyzer, a UV fluorescence SO_2 analyzer, and an laser infrared spectrometry ammonia analyzer.

The majority of non-refractory PM_1 was organic (0.60 ± 0.14) and sulfate (0.27 ± 0.10). The aerosol appeared to be highly acidic (57.0 ± 0.2% of predicted ammonium). Factor analysis indicates that organic mass was primarily oxygenated, which increased during heat waves. The expected diurnal NO_x and O_3 anticorrelation was observed throughout the campaign. The average daily maximum O_3 was 57.7 ± 2.5 ppb, with peaks above 90 ppb during the early heat wave. NO levels were largely below NO_2 levels. The SO_2 concentration approached the detection limit, averaging of 1.5 ± 1 ppb. SO_2 was sometimes correlated with aerosol sulfate, but other times showed little correspondence.

Further analysis will seek to identify distinct sources of organic aerosol through factor analysis and connections to the OA factors and indicators of photochemistry.

2UA.12

Characterization of Microplastics in the Atmosphere in the Eastern United States. ALEXIS SMITH, Heather Neel, Danielle Haller, Marwa El-Sayed, Foram Madiyar, *Embry-Riddle Aeronautical University*

Microplastics (MPs) are defined as small fragments of plastic that are less than 5mm in size. Previous research has primarily focused on MPs in the marine environment; however, characterization of MPs in the atmosphere is yet limited. The goal of this study is to characterize the concentration and composition of MPs in the atmosphere. Filter-based ambient sampling of MPs is routinely conducted to provide insight into their concentrations and deposition rates. However, other atmospheric particles are also collected onto these filters during sampling. To eliminate these particles from the samples, previous studies used chemical solutions as a pretreatment step prior to MPs characterization. However, to the best of our knowledge, no study has investigated the conditions at which this pre-treatment step should be conducted without altering the shape and size of the collected MPs . Herein, a sample pre-treatment methodology was investigated for two widely used MPs, namely Polystyrene (PS) and Poly(methyl methacrylate) using multiple concentrations of nitric acid (acid), potassium hydroxide (base), and hydrogen peroxide (oxidizing agent) at various temperatures. Preliminary results show that for PS, such conditions occur at 15% H_2O_2 at room temperature. To validate our method, optimum pre-treatment conditions are tested on ambient samples collected at Embry-Riddle Aeronautical University campus in Daytona Beach, Florida. Active and passive sampling is conducted using the Tisch High Volume Air Sampler, and a setup devised to hold the glass filter, respectively. Optical and chemical characterization of MPs is conducted using a ZEISS Axioscope 7 compound microscope to determine their size distribution and a Fourier transform infrared (FTIR) spectroscopy to investigate their chemical properties, respectively. This study has implications for the effects of MPs on human health via inhalation, as well as their effects on water bodies and soil upon deposition.

2UA.13

Development and Evaluation of a Multi-stage Cascade Impactor for the Collection of Ambient Particulate Matter on Gelatin Filter. Mohammad Aldekheel, Vahid Jalali Farahani, RAMIN TOHIDI, Constantinos Sioutas, *University of Southern California*

In this study, we developed and evaluated the performance of a high-volume and multi-stage cascade impactor for the collection of fine and ultrafine particles. This cascade impactor operates at a flow rate of 100 lpm and has two impaction stages with 50% cut-point diameters of 2.5 µm and 0.2 µm, respectively, to separate particles into three size groups: <0.20 µm, 0.20-2.5 µm, and >2.5 µm. The performance of the impactor was evaluated in the laboratory using monodisperse polystyrene latex (PSL) particles as well as polydisperse ammonium sulfate, sodium chloride, and ammonium nitrate aerosols to experimentally obtain the 50% cut-point of each impaction stage. Additionally, lab tests were conducted using our impactor and the Personal Cascade Impactor Sampler (PCIS) to compare the mass concentration of collected particles. The findings of this study showed that the experimentally determined parameters of the impactor, including the 50% cut-point diameters, agreed with the theoretical predictions. Furthermore, the average mass concentration of particles using our designed impactor was in a very good agreement with the PCIS. This impactor has been developed primarily to collect particles on water-soluble gelatin filters which require gentle handling, and efficiently maintain viable biological material. These filters can easily dissolve in water allowing for the extraction of water-insoluble particles into the slurries, for the use in in-invitro and in-vivo exposure studies.

3AC.1

Quantifying the Chemical Composition and Mass Loading of Microplastic Submicron Particles (MPPs) in the Atmosphere using Real-time Aerosol Mass Spectrometry. SINING NIU, Ruizhe Liu, Sahir Gagan, Nicolas Aliaga Buchenau, Sarah Brooks, Jason Surratt, Xingmao Ma, Manjula Canagaratna, Yue Zhang, *Texas A&M University*

The prevalence of microplastics detected in the ecosystem is an emerging problem worldwide. Microplastics have been shown to not only have adverse implications on human health, but also contribute to climate forcing in the aerosol form by efficiently scattering shortwave radiation and absorbing longwave radiation. Despite their increasing importance, a real-time detection method for atmospheric microplastic particles (MPPs) has not yet been established. Instead, analyzing atmospheric MPPs often involves complicated sample collection and preparation procedures, followed by offline analysis methods.

Herein, to our knowledge we provide the first real-time measurement study to quantify atmospheric MPP concentrations. A high-resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS) is employed to detect submicron polystyrene (PS) particles, one of the most abundant microplastics produced. A calibration curve for determining the mass concentration of atmospheric MPPs is established by sampling monodisperse PS particles with the AMS, and the relative ionization efficiency is 2.0. Several tracer ions, including those at mass-to-charge ratios (*m/z*) 78 and 104, are shown to be unique to PS-containing particles. Positive matrix factorization (PMF) is applied to AMS data collected from externally-mixed PS particles with laboratory-generated inorganic and secondary organic aerosols, to mimic complex aerosol mixtures. The MPPs PMF factor is successfully derived and highly corrected with the pure PS mass spectrum (R^2=0.93).

Ambient particles are also collected and analyzed by the constrained PMF (multilinear engine, ME-2) to determine the temporal distribution of MPPs. A distinct factor that is highly correlated to the pure PS profile is separated. The average PS mass concentration is estimated to be 17 ng/m^3 with a detection limit of 3 ng/m^3 during a 48-hour sampling period. The methodology and results of our study can improve the understanding of the atmospheric transport, life cycle and climate effect of MPPs (an emerging pollutant of rising concern).

3AC.2

Airborne Microplastics in a Suburban Location in the Desert Southwest. KANCHANA CHANDRAKANTHAN, Pierre Herckes, *Arizona State University*

Microplastics are rapidly emerging anthropogenic stressors that pose a potential threat to ecosystems and human health. They are defined as plastic particles that are less than 5 mm in size. Microplastics are either intentionally manufactured at a microscopic size or result from the fragmentation of larger plastic litter. While the ubiquitous nature of microplastics in water has been well documented, studies on their distribution in the air are limited. Microplastics in suspended particulate matter in the atmosphere is important in assessing microplastic contamination within a breathing zone. Owing to their small size and low material density, microplastics can be easily inhaled and pose a potential threat on humans. An additional concern arises from the additives used in plastic manufacturing and adsorbed hydrophobic organic pollutants such as Polycyclic aromatic hydrocarbons (PAHs). In addition to the concentration, it is important to understand the chemical composition of microplastics. Chemical characterization will yield information on the nature of the microplastics present and therefore provide an insight into their origin and toxicity.

Here we investigate and present results for the occurrence of microplastics in suspended particulate matter and total atmospheric fallout in a suburban location in the desert Southwest, and thereby aim to contribute to the limited existing knowledge of their occurrence in the air. Samples were collected, processed and microplastics were counted under an optical microscope to obtain quantitative information of their distribution in air. Microplastics were present in all collected suspended particulate and total atmospheric fallout samples ranging from between 0.02 to 1.1 microplastics/m3 (average concentration of 0.2 microplastics/m3) and 71 to 389 microplastics/m2/day (average deposition flux of 178 microplastics/m2/day) respectively. Micro-Raman spectroscopy was used to identify the chemical composition of microplastics in suspended particulate matter. Chemical characterization results revealed an array of polymers for the airborne microplastics.

3AC.3

Source Characterization and Quantification of Atmospheric Nanoplastics. MICHAEL TAWADROUS, Arthur W. H. Chan, Alex Lee, *University of Toronto*

Since the creation of the first fully synthetic plastic in 1907, billions of tonnes of plastics pollutants have been released into the environment. Owing to its long lifetime, plastic debris is readily transported and accumulates in various environmental compartments even in the most remote areas. Bioaccumulation of nanoplastics (NPs) and their associated chemical additives could occur in organisms including humans upon ingestion/inhalation causing cytotoxicity. In this study, we aim to measure the physicochemical characteristics of airborne NPs in indoor and outdoor environments. Scanning Mobility Particle Sizer (SMPS) and Aerosol Mass Spectrometer (AMS) are used to characterize size and bulk composition in situ, and pyrolysis gas chromatography/mass spectrometry (Py-GC/MS) is used to characterize polymer composition and their chemical additives in offline filter samples. The plastic particles are collected from a 3D printer in a closed chamber. Different printing filament types are used to generate particles under different printing temperature. The initial results show that particles generated from the 3D printer using ABS (Acrylonitrile Butadiene Styrene) reached about 19,000 p/cc. Information from AMS mass spectra and Py-GC/MS are discussed in greater detail. Furthermore, a tube furnace is used to generate a steady stream of particles that are characterized by mass spectrometry. Detecting degradation products from NPs and the changes in composition from atmospheric aging will help in understanding the impact of NPs abiotic degradation on the environment and human health.

3AC.4

Organic Markers for the Detection of Ship Plumes in Single-particle Mass Spectrometry. JOHANNES PASSIG, Lukas Anders, Julian Schade, Ellen-Iva Rosewig, Paul Haubenwallner, Robert Irsig, Sven Ehlert, Thorsten Streibel, Andreas Walte, Thomas Adam, Ralf Zimmermann, *Helmholtz Zentrum München and University of Rostock*

Shipping is a main source of air pollution, substantially affecting climate and public health. Up to 400,000 annual deaths were attributed to ship emissions (Sofiev et al., 2018). Especially in populated coastal regions, the contribution of ships is difficult to quantify. Ship plume measurements require either clean air conditions or use transition metals as source markers (Passig et al., 2021). While the sensitivity of single-particle mass spectrometry (SPMS) to metals has been improved (Passig et al., 2020), metals as ship emission markers loose importance because of distillate fuels and exhaust cleaning devices to meet new regulations, emphasizing the need for novel marker approaches. Recently, chemical coverage of SPMS was extended to traces of polycyclic aromatic hydrocarbons (PAHs) (Schade et al. 2019). Since they are by-products of any combustion, they might also work as markers for distillate fuels.

Here we present the first SPMS experiments at a ship engine. With the new PAH-sensitive technology, we measured PAH mass spectra for different fuels. Fuel-specific signatures were observed independently of the engine loads, i.e. rows of alkylated phenanthrenes that dominate the PAH mass spectra.

The applicability of the new marker concept was tested by ambient air measurements under real-world conditions. We found the aforementioned PAH patterns in coastal regions and could attribute them to ship traffic. We also detected a ship plume by the PAH emissions; from a distance of about 15 km.

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3AC.5

Primary Emissions and Secondary Aerosol Formation from In-use Heavy-Duty Diesel and Natural Gas Vehicles. SAHAR GHADIMI, Hanwei Zhu, David R. Cocker III, Thomas D. Durbin, Georgios Karavalakis, *University of California, Riverside*

Heavy-Duty Vehicles (HDVs) are major contributors to urban air pollution due to elevated tailpipe nitrogen oxide (NOx) and particulate matter (PM) emissions. Fuel type, driving conditions, and exhaust aftertreatment technologies are known to impact vehicle primary emissions, but less is known about their effect on secondary aerosol (SA) formation. In this study, tailpipe emissions and SA formation from in-use HDVs were assessed. The diesel-powered HDVs were operated with ultra-low sulfur diesel (ULSD) and hydrogenated vegetable oil (HVO), while the natural gas HDVs were operated with compressed natural gas (CNG). Testing was conducted on a chassis dynamometer over the Urban Dynamometer Driving Schedule (UDDS), the Refuse Truck Cycle, the Goods movement cycle, and the CARB HHDDT cruise mode cycle.

In summary, CNG vehicles produced higher ammonium nitrate containing secondary aerosols (up to ~450 mg/mile) compared to diesel HDVs. Inadvertent lubricant oil consumption (confirmed by AMS analysis) in two CNG vehicles was the major source of organic aerosols (up to ~80 mg/mile). HVO fuels resulted in lower precursor emissions and ultimately lower SOA formation compared to ULSD. Generally, secondary aerosol mass production during photochemical aging significantly exceeded primary tailpipe PM emissions. Our results suggest that diesel HDVs with functioning DOC/DPF aftertreatment systems will likely decrease SOA precursor emissions. The use of renewable and aromatics-free HVO will result in lower SOA formation than petroleum diesel. CNG vehicles will likely have a greater contribution to urban SOA formation than current technology diesel vehicles, with a significant contribution to secondary inorganic aerosol.

3AC.6

Exploring the Effects of Chemical Composition on Viscosity of Secondary Organic Aerosol from n-alkanes Oxidation.
TOMMASO GALEAZZO, Bernard Aumont, Manabu Shiraiwa, *University of California, Irvine*

Secondary organic aerosols (SOA) are major components of atmospheric particulate matter, affecting climate and air quality. Mounting evidence exists that SOA can adopt a viscous state, which may impact formation and partitioning of SOA. Viscosity of SOA can be estimated from the glass transition temperature (T_g) of constituting species and their concentrations in SOA. Recently we developed the tgBoost model for predicting T_g of organic molecules by using machine learning algorithms and molecular embeddings. tgBoost has a mean absolute error of 18.3 K, and it predicts T_g considering molecular functionality and structure, hence distinguishing between compositional isomers.

We simulated gas-phase oxidation of *n*-alkanes under high NO_x conditions and subsequent SOA formation using the GECKO-A (Generator of Explicit Chemistry and Kinetics of Organics in the Atmosphere) model. We implemented tgBoost into GECKO-A and explored the impacts of chemical composition on viscosity. The simulated SOA yields, masses and viscosities were compared to chamber experiments to evaluate the role and impacts of gas-phase chemistry and phase state on SOA formation. We also explored the molecular composition of SOA and highlighted the role of functionality in simulating SOA viscosity.

3AE.1

PM2.5 and PM0.1 Exposure Analysis for Oregon's Clean Transportation Fuel Program: Public Health Impacts and Environmental Justice. YITING LI, Michael Kleeman, *University of California, Davis*

Emissions from mobile sources contribute to increased concentrations of airborne particles that cause excess deaths in cities across the United States. This public health burden falls most heavily on the population living closest to major transportation corridors, leading to exposure disparities between different socio-economic classes. Recent studies in California demonstrated that adoption of low carbon fuels can reduce the exposure disparities between socio-economic classes and improve air quality for all people. The state of Oregon recently began adoption of clean transportation fuel policies that are similar to those developed in California, which should likewise yield air quality improvements. Oregon's policies encourage fuel producers and importers to reduce the carbon intensity (CI) of conventional liquid fuels to meet GHG emission targets. In 2020, Governor Kate Brown issued Executive Order 20-04 specifying a 20% CI reduction by 2030 and a 25% CI reduction by 2035.

Here we analyze the emissions and air quality outcomes of three future scenarios for transportation fuels in Oregon: (i) a Business as usual (BAU) scenario that does not encourage adoption of low carbon fuels, (ii) a Clean Fuel Program (CFP) scenario, which represents adoption and successful achievement of the proposed 25% CI reduction; and (iii) a maximum ambition scenario (CFP MAX), which evaluates a 37% CI reduction. Transportation emissions under all scenarios were analyzed using the MOVES model for every county in Oregon. Detailed emissions with 4 km spatial resolution were then developed for each scenario by scaling the National Emissions Inventory (NEI) for the year 2017 based on the factors from the MOVES analysis. Annual-average air quality in the year 2035 was simulated using the UCD/CIT chemical transport model that enables a detailed analysis of PM2.5, PM0.1, and O3. Exposure fields were analyzed using the BenMAP model to predict public health outcomes stratified by income categories and race / ethnicity categories. Adoption of low-carbon transportation fuels improves air quality in Oregon, yielding public health benefits of approximately $80M/yr. Adoption of low carbon transportation fuels furthermore reduce exposure disparities between residents in different income categories. Changes to exposure patterns based on race/ethnicity were more complex. Exposure patterns differ for PM2.5 and PM0.1 due to the combined effects of infrastructure configuration and population demographics within major cities in Oregon. Implications for the effects of low carbon transportation fuels in Oregon and other locations will be discussed.

3AE.2

Impacts of a Cookstove Intervention in Urban Zambia on Cooks' Personal Exposure to Carbon Monoxide and Particulate Matter. STEPHANIE PARSONS, Wesley Hayes, Joseph Pedit, Logan Richardson, Pamela Jagger, Andrew Grieshop, *North Carolina State University*

Solid fuel use for cooking results in poor indoor air quality. Various private enterprises distribute alternative technologies to address this through improved combustion performance. We conducted a stove intervention trial in Lusaka, Zambia, where charcoal is the primary fuel (89%) in most households, in collaboration with two stove distribution companies in four neighborhoods, two with existing use of alternative stoves (Matero, Kamanga) and two with traditional stoves and marketing of alternative stoves between baseline and endline (Kalingalinga, Ngombe). We measured carbon monoxide (CO, 496 baseline, 271 endline) and particulate matter ($PM_{2.5}$, 68 baseline, 31 endline) personal exposure of cooks in these neighborhoods. Cooks wore Lascar CO monitors and MicroPEM (baseline) and Atmotube Pro (endline) $PM_{2.5}$ monitors at breathing height for 24 hours. We compared Atmotube and MicroPEM performance via stationary and personal exposure collocations. Atmotube collocation averages were on average within 7.0% of MicroPEM gravimetric filter measurements (n=2) but the average R^2 for collocations was 0.18. Endline pollutant exposures were approximately 50% of baseline exposures across all neighborhoods, with Matero cooks having the lowest 24-hour average CO exposure in both phases (4 ppm). 24-hour $PM_{2.5}$ exposures were consistent, but above health guidelines, for all neighborhoods both during baseline (97 +/- 61 $\mu g\ m^{-3}$) and endline (41 +/- 28 $\mu g\ m^{-3}$). Cooks who stopped using alternative stoves between baseline and endline had the smallest difference in CO exposure, suggesting disadoption had a negative impact on exposure. Adoption of alternative stoves was not associated with an impact. Diurnal trends were similar across neighborhoods but differed between pollutants. CO peaked at mealtimes while $PM_{2.5}$ peaked in the morning and evening. Diurnal $PM_{2.5}$ exposure was similar to ambient trends from PurpleAir monitors in Kabwe (baseline) and Lusaka, Zambia (endline), suggesting exposure is dominated by regional background levels rather than cooking.

3AE.3

The Pioneer Valley Healthy Air Network: Strategies for Establishing a Community-driven Low-cost Sensor Network. DONG GAO, Jiarong Qi, Anna Woodroof, Mahea Heimuli, David Bloniarz, Alexander Sherman, Kayla Fennell, Samantha Hamilton, Yoni Glogower, Sarita Hudson, Krystal Godri Pollitt, *Yale University*

Air pollution continues to be a global public health threat. With the development of sensor and internet technologies, low-cost air sensors have emerged as an effective tool for hyperlocal air quality monitoring and can help answer community-driven and locally motivated questions. The Pioneer Valley Healthy Air Network was recently created in Western Massachusetts through a partnership between local community groups, city officials, non-for-profit organizations, health care facilities, academic researchers, and residents in the cities of Springfield, Chicopee and Holyoke. The network currently includes 60 Purple Air PA-II-SD and Tetrad AirU sensors that measure real-time PM2.5 mass and ozone concentrations. The goal of the network is to conduct high-quality air quality measurements in environmental justice communities known to have the highest rates of asthma in the country and to educate and inform residence of local air quality issues and actions to mitigate exposure. We developed a formal approach for optimally locating a dense network of low-cost sensors and derived an area-specific calibration model. Combined bottom-up and top-down approaches were used to determine locations for sensor deployment. Residents identified sites of concern/interest and this information was paired with a weighted site selection analysis. This site selection analysis was performed by assigning varying importance levels to different factors such as traffic density, proximity to emission hotspots, and distribution of at-risk vulnerable populations. To ensure high-quality data is shared with the community, pre- and post-deployment calibrations are conducted. For pre-deployment calibration, all sensors were collocated at a regulatory station for a minimum of two weeks. Sensor data was compared to reference methods, and calibration factors were derived for each sensor. Inter-comparison of sensor data showed good correlation between sensors (R2=0.98~0.99). An interactive dashboard was created using Power BI to monitor the sensor health and produce real-time charts, average levels, and alerts. Successes and challenges with establishing this air monitoring network will be shared.

3AE.4

Traffic and Cooking Emissions Drive Exposure Disparities to Airborne Fine Particles in the United States. PROVAT SAHA, Albert A. Presto, Steven Hankey, Julian Marshall, Allen Robinson, *Carnegie Mellon University*

Although past studies have reported higher exposures of airborne fine particulate matter (PM2.5) for the racial-ethnic minority population in the US, the emission sources that drive the disparities are largely unexplored at a national scale. In this study, we combine high-spatial-resolution (census block level) national estimates of source-resolved PM2.5 components (e.g., traffic, cooking, and other) with publicly available demographic data (census block-group level) to determine exposure disparities by race-ethnicity, income, and urbanicity across the United States. Our results reveal that exposure disparities for total PM2.5 are mainly driven by the primary particle emissions from traffic and cooking sources. The contribution of cooking PM2.5 to exposure disparities is comparable to that of traffic. For both traffic and cooking primary PM2.5 components, exposures are much larger for racial-ethnic minority populations than white populations. Differences in income do not explain the racial-ethnic exposure disparities. Source-specific targeted emission reductions will be important to reduce the racial-ethnic exposure disparities for PM2.5 in the US.

3AE.5

Transformation of the Urban Transport Towards Low- and Zero-tailpipe Emission Technologies: Impacts on Commuter Exposure to Black Carbon, PM2.5, and UFP.

RICARDO MORALES BETANCOURT, Boris Galvis, Olga Lucia Sarmiento, *Universidad de los Andes*

Commuters are often exposed to high concentrations of air pollutants due to its proximity to mobile sources and to other characteristics of transport micro-environments. Recent trends, driven by the need to curb air pollution and mitigate greenhouse gas emissions from transport, has accelerated the inclusion of zero- and low-tailpipe emission alternatives in many areas worldwide. These changes are expected to reduce overall commuter exposure. However, the assessments of these transformations on commuter exposure are limited by the low frequency of such studies. In this work, we use a unique data set of personal exposure concentrations measurements of equivalent Black Carbon (eBC), $PM_{2.5}$, and UFP collected over the span of 6 years to analyze the rapid changes in commuter exposure experienced by citizens of Bogota, in Colombia. The city, which has endured persistent air pollution challenges and has been shown to have extremely high levels of air pollution exposure in the past, has seen rapid adoption of cleaner public transport alternatives. Its bus-based mass transit system, which operates large-capacity buses, recently replaced over a thousand Euro-II and III diesel-powered buses with Euro-VI compressed natural gas (CNG) and DPF-equipped Euro-V diesel buses. Furthermore, a remanent of outdated diesel buses from its public transport system were replaced with the largest fleet of fully electric buses outside of China (1480 fully electric buses). Additionally, the last two years also saw the inclusion of thousands of CNG in the public transport fleet. In this work, we report our measurements of personal exposure concentrations of eBC, $PM_{2.5}$, and UFP before and after the public transit transformations. Our observations show significant reductions in the concentration of $PM_{2.5}$ and eBC, of up to 80% in some cases. Results also show persistently high levels of UFP concentration (between 65000 and 104500 #/cm3) in the near-road environment as well as in the in-cabin environment. The data set reported in this work demonstrates the rapid reductions attained by the adoption of stricter emissions standards and the observable immediate co-benefits of climate mitigation actions. Such results can be of use for other regions in the world were there has been hesitancy in adopting such technologies.

3AE.6

Morphological Characterization and Mixing State of Size Segregated Aerosols in Northern India.

HIMANSHI ROHRA, Gursumeeran Satsangi, Ajay Taneja, *Savitribai Phule Pune University, Pune, India*

Morphometric characterization of PM in quasi-accumulation (PM0.5-1.0, PM0.25-0.5) and quasi-ultrafine (PM0.25) modes collected through cascade impactor in indoors of residential homes (separated by socio-economic status (SES)) were performed using electron microscopy (SEM-EDX) in Agra, India. Bimodal distribution with the primary mode in 0.25-0.5µm with high mass loading in low-income groups (LIG) was noted. Different kinds of particles like soot, tarballs, and dust particles were observed. Shape descriptive parameters like circularity (0.62-0.72), sphericity (0.10-2.88) aspect-ratio (AR) (1.50-1.88), roundness (RN) (0.18-0.98) indicated non-sphericity of particles. Size dynamics revealed inverse and direct relation of RN and AR respectively with a higher aerodynamic diameter of particles, inferring elongation of larger sized-particles. EDX spectra revealed fewer concentrations of crustal elements in ultrafine and LIG indicating anthropogenicity. Overall, findings suggest that fuel activity, SES have a significant effect on the morphometry of particles that exacerbate the implications to improve IAQ by switching from solid to cleaner fuels.

3BC.1 (Invited)

Characterizing the Impacts of Biomass Burning to Indoor and Outdoor Environments During Wintertime in Fairbanks, Alaska: An overview of the ALPACA House Measurements.

PETER F. DECARLO, Ellis Robinson, Andrew Holen, Judy Wu, Kerri Pratt, Karolina Cysneiros de Carvalho, Brent Williams, Damien Ketcherside, Vanessa Selimovic, Robert J. Yokelson, Lu Hu, Ting Fang, Sukriti Kapur, Kasey Edwards, Manabu Shiraiwa, Kayane Dingilian, Yuhan Yang, Michael Battaglia, Rodney J. Weber, Tianren Wu, Dusan Licina, Jingqiu Mao, William Simpson, *Johns Hopkins University*

The **A**laskan **L**ayered **P**ollution **A**nd **C**hemical **A**nalysis (ALPACA) Campaign took place in Fairbanks, AK in January and February of 2022. Cold and dark conditions prevalent Arctic and Sub-arctic cities during winters frequently lead to the build-up of air pollution. The highest levels of outdoor air pollution are frequently driven by home heating, particularly biomass combustion. As a part of the larger ALPACA effort, a residential home in Fairbanks was selected as a measurement site for detailed chemical measurements of outdoor and indoor air pollutants. This presentation will focus on an overview of the house research team results including the characterization of outdoor-to-indoor transport under high pollution levels with extreme temperature gradients (~50C) and the impact of pellet stove usage in the home and other typical residential activities on indoor air quality. The research team used a suite of state-of-the art instrumentation set up in the attached garage inside the house to measure both indoor and outdoor particles and gases. Detailed aerosol and trace gas composition were measured by a suite of instruments including HR-AMS, ATOFMS, SV-TAG, PTR-ToF-MS, WIBS, and cavity ringdown spectroscopy. Health relevant properties of aerosol were investigated using measurements of reactive oxygen species and environmentally persistent free radicals.

3BC.2

Understanding Alaskan Wintertime Air Pollution: Outdoor-Indoor Transport and Phase Partitioning of Chemically Resolved Semi-Volatile Organic Compounds during the ALPACA 2022 Campaign.

KAROLINA CYSNEIROS DE CARVALHO, Ellis Robinson, Andrew Holen, Judy Wu, Vanessa Selimovic, Damien Ketcherside, William Simpson, Lu Hu, Kerri Pratt, Peter F. DeCarlo, Robert J. Yokelson, Brent Williams, *Washington University in St. Louis*

Alaska is often thought of as a place to escape from urban air pollution, with its vast and pristine wilderness. However, with limited sunlight and temperatures reaching below -40ºC, Arctic and Subarctic cities are challenging places to live during the winter. These extreme conditions lead to an increase in local particulate matter emissions due to more intense domestic heating and power generation. The cold temperatures, in conjunction with reduced solar radiation, are responsible for stronger temperature inversions that trap these pollutants in the lower atmosphere, resulting in very poor outdoor air quality.

While spending most of their time indoors during the winter, Alaskan residents experience higher exposure to air pollution during this season due to outdoor-indoor air infiltration, indoor pollution sources, and chemical transformations. However, the understanding of atmospheric chemical reactions of these pollutants is poor and so is the extent of human exposure risks in this unique environment. The Alaskan Layered Pollution And Chemical Analysis (ALPACA) field project occurred during the 2022 winter in Fairbanks, Alaska to improve our understanding of how pollutants behave under these cold and dark conditions.

A Semi-Volatile Thermal desorption Aerosol Gas chromatograph (SV-TAG), capable of identifying and quantifying speciated organic compounds in both gas and particle phases, was deployed inside the garage of a residential home, along with complementary gas-phase (PTR-ToF-MS - Proton Transfer Reaction Time-of-Flight Mass Spectrometer) and particle-phase mass spectrometers (ATOFMS - Aerosol Time-of-Flight Mass Spectrometer and AMS - Aerosol Mass Spectrometer). The TAG system is composed of two collection cells that provide direct measurement of phase partitioning. This presentation discusses indoor and outdoor organic aerosols sampled during the seven-week study. Results include understanding the extent of particle-to-gas phase partitioning of semi-volatile organic compounds upon warming due to transport indoors, the major sources that contributes to indoor and outdoor air pollution, as well as the relationship between indoor and outdoor aerosol composition.

3BC.3

Coupled Indoor-Outdoor Aerosol Mass, Composition, and Size Measurements from a Residential Home in Fairbanks, Alaska during ALPACA 2022. ELLIS ROBINSON, Andrew Holen, Judy Wu, Kerri Pratt, Karolina Cysneiros de Carvalho, Brent Williams, Damien Ketcherside, Vanessa Selimovic, Robert J. Yokelson, Lu Hu, Ting Fang, Kasey Edwards, Sukriti Kapur, Manabu Shiraiwa, Kayane Dingilian, Yuhan Yang, Michael Battaglia, Rodney J. Weber, Tianren Wu, Dusan Licina, Jingqiu Mao, William Simpson, Peter F. DeCarlo, *Johns Hopkins University*

High northern latitude urban areas represent an under-studied air quality context despite having strong emissions sources and meteorological conditions that regularly lead to bad air quality, and expected growth in population in the coming decades. Fairbanks, Alaska is a canonical example, where sources and meteorology interact to regularly create intense air pollution episodes. The Alaska Layered Pollution And Chemical Analysis (ALPACA) campaign was established to better understand the sources and meteorological conditions present in high-latitude cities during wintertime, using Fairbanks as a test-case. As part of ALPACA, a residential house was used as a field-site for coupled indoor-outdoor air pollution sampling, to better understand indoor exposures to outdoor air pollution, outdoor-indoor transformations, and source characterization of typical indoor PM sources (e.g., pellet stove, cooking, incense burning). Here our focus is high time-resolution aerosol mass, composition, and size measurements from a HR-ToF-AMS. We identify major outdoor PM sources using Positive Matrix Factorization source-apportionment, and illustrate how those sources are transformed upon transport indoors. We also report indoor air-quality (IAQ) metrics such as air exchange rates, indoor-outdoor (I/O) pollutant ratios, and indoor-outdoor transport timescales. Our results add to the literature on air pollution in cold and dark cities, as well as the IAQ literature.

3BC.4

Impact of Residential Wood Burning on Physical, Chemical, Optical, and Biological Characteristics of Subarctic Aerosols in Northpole, Alaska, during Wintertime. RAGHU BETHA, Kaitlyn McKinney, Saravanan Kanagaratnam, Anastasia Hewitt, Srijan Aggarwal, Subhabrata Dev, Dominique Pride, *Texas Tech University*

Interior Alaska regions are prone to episodes of poor air quality, especially during wintertime. Extremely low winter temperatures, valley-like topography, high latitude, and lack of winds make the region susceptible to frequent temperature inversions. Due to fuel poverty, where a household spends a disproportionately large percentage of its income on energy needs such as residential heating, many residents in Alaska still rely on wood-burning as the primary source of residential heating. The emissions from the residential wood burning combined with temperature inversion led to frequent exceedance of the 24-hr PM2.5 standards. In this study, we used real-time instruments and filter samplers to characterize and determine sources of atmospheric aerosols in Interior Alaska during wintertime. More specifically, we examined the influence of meteorological parameters and anthropogenic activities on particle size, mass and number, carbon fractionation, chemical speciation, particle absorption, and biological fractions of atmospheric aerosols. We will discuss the observed elevation of particle concentrations, alteration to their physicochemical properties, and the distinct nature of bioaerosols during the region's temperature inversions and wood-burning episodes. In addition, we will present the specific markers for detecting residential wood burning smoke in the air along with methods to estimate the source contributions.

3BC.5

Single Particle Emission Measurements of Black Carbon from Residential Wood Combustion. REBECCA TROJANOWSKI, Arthur J. Sedlacek, Thomas Butcher, Ernie R. Lewis, Vasilis Fthenakis, *Brookhaven National Laboratory*

As of 2015, residential wood combustion (RWC) devices were responsible for more than 45% of PM2.5 (particles with an aerodynamic diameter < 2.5µm) in Europe. Similarly, biomass burning in the United States (US) accounts for more than one-third of primary PM2.5 emissions and the US Environmental Protection Agency (EPA) lists the three largest sources of PM2.5 as utility fuel, RWC, and prescribed burning (land management tool to maintain forest health). While biomass is often seen as a carbon neutral fuel, it suffers from higher particulate matter (PM) emissions in comparison to oil or natural gas fired systems. To securely promote the use of biomass as a renewable fuel source, it becomes very important that we are aware of how wood smoke contributes to ambient air quality and the environment. In order to provide information to regulatory agencies, Brookhaven National Laboratory's (BNL) Interdisciplinary Science Department and the Environmental and Climate Science Department have focused on quantifying the microphysical and optical properties of black carbon (BC) emissions, a major component of PM2.5, from residential biomass heating devices. Understanding the BC and organic concentrations of particles produced from different biomass combustion units can provide insightful information on how maximizing complete combustion through different control parameters (temperature and oxygen sensors, the use of modulating fans or dampers) and/or fuel can affect the emissions. This study focuses an advanced gasification woodchip-fired boiler. Specifically, this work discusses the use and results using a single-particle soot photometer (SP2).

3BC.6

Black and Brown Carbon Emissions during Realistic Operation of Two Residential Cordwood-Fired Hydronic Heaters. JAKE LINDBERG, Rebecca Trojanowski, Marilyn Wurth, Brian P. Frank, Shida Tang, Gil H. LaDuke, Thomas Butcher, Devinder Mahajan, *Brookhaven National Labs*

Inefficient combustion of solid fuels, such as cordwood, produces large quantities of black and brown carbon (BC and BrC). These particle types are important as they have noted effects on health and the climate. Biomass combustion derived carbonaceous particulate matter is especially relevant in areas with a high proportion of wood combustion devices and geographic locations which are prone to air inversion events. Further realistic operating patterns for these devices, whereby most operators in a local area start their device at approximately the same time, and the fact that these devices produce much more pollution at start-up than during typical operating conditions, can lead to extremely high spatiotemporal concentrations of pollutant emissions, including BC and BrC. In this study, we describe the BC and BrC emissions from two residential cordwood hydronic heaters over a wide range of operating conditions, such as cold-starts, warm-starts, four different levels of output ranging from 15% to 100% maximum rated output, and periods of repeated cycling. The range in flue-gas BC concentrations, measured using an aethalometer at the 880 nanometer (nm) wavelength, were between 500 and 22,400 micrograms per cubic meter (ug/m3). Within this range the average value measured during cold-start was 3-6 times larger than the test average value. The BrC concentrations, measured using the 370 nm wavelength of an aethalometer, were between 90 and 35,600 ug/m3, where the cold-start average was greater than the BrC test average for one appliance/technology and lower for the other appliance. The calculated Angstrom Absorption Exponent (AAE) of the flue-gas aerosol ranged between 1.54 and 3.63, which is on the low end of accepted values for woodsmoke.

3HA.1

Characterization of Airborne Metals in a Pennsylvania Urban-Industrial Area: Polluted Background and Exposures to Fenceline Communities.

MINA TEHRANI, Edward Fortner, Benjamin Werden, Tara Yacovitch, Ellis Robinson, Roger Sheu, Scott Van Bramer, Thomas Burke, Kirsten Koehler, Keeve Nachman, Ana Rule, Peter F. DeCarlo, *Johns Hopkins University*

The Chester-Trainer-Marcus Hook Pennsylvania area is home to a refinery, waste incinerator, and petrochemical plants, some abutting residential communities. EPA analyses indicate that trace metal emissions from local industries pose major health risks. Existing information on metals air pollution in the area is based on 1/6-day filter sampling at two sites and EPA National Air Toxics Assessment (NATA) modeling, which incorporates industry self-reporting. Incomplete data are available regarding fenceline community exposures. This study aimed to 1) compare current size-resolved metals concentrations in particulate matter (PM) in the Chester-Trainer-Marcus Hook area with existing reports, and 2) explore source identification using fixed-site and mobile measurements. Size-segregated integrated PM was collected on filters via micro-orifice uniform deposit impactor (MOUDI) at a Widener University fixed-site during a 3-week campaign in September 2021 and analyzed by ICP-MS. On-line aerosol measurements were conducted by Soot Particle AMS via mobile laboratory. NATA-estimated concentrations of metals in total PM were lower ($p<0.001$) than fixed-site measurements for arsenic, lead, antimony, cobalt, chromium and manganese. Toxic trace elements arsenic, lead and cadmium were predominantly observed in fine PM (<1 µm), the fraction which can penetrate deeply into the lungs. Strong correlations ($r_s > 0.6$) between MOUDI and mobile measurements at the fixed site were found for lead, aluminum, potassium and selenium. Elevated metals levels (e.g., cadmium, arsenic and lead) were observed near the waste incinerator and Marcus Hook refinery complex. These results suggest potential co-exposures to toxic trace elements in communities surrounding the Chester-Trainer-Marcus Hook industrial area, with levels of six metals significantly exceeding NATA estimates. Further work is needed to characterize the cumulative risk of these inhalation exposures.

3HA.2

Measurement for Investigating Aerosol Toxicity, Using Centrifugal Classification of Suspended Particles for Cell Exposure and in Vitro Evaluation Using Thp-1 Macrophages.

KAKO OGANE, Ayumi Iwata, Tomoaki Okuda, *Keio University*

Airborne particulate matter (PM) is of a global public health concern due to a variety of adverse health effects. Evaluation of the health effects of PM should reflect physicochemical properties especially size. Among various methods, in vitro models are often used as a convenient screening procedure for assessing the adverse effects of air pollutants including PM. For in vitro testing, we need to prepare suspensions composed of PM. In this study, we made a method of size-fractionated particle suspension using centrifuge and we investigate the effects of size-fractionated suspension PM on THP-1 cells in relation to their physicochemical properties.

We used THP-1 cells differentiated with phorbol 12-myristate 13-acetate (PMA) as a model for macrophages in the survey. THP-1 cell line was exposed by copper particles with six different diameters (concentration: 5, 10, and 50 µg/mL for 24 h) to measure cell viability using a colorimetric assay for 96-well plates with 2-(4-iodophenyl)-3-(4-nitrophenyl)-5-(2,4-disulfophenyl)-2H-tetrazolium monosodium salt (WST-1). Each different sizes of cooper median diameter were 1.15, 4.47, 5.12, 26.1, 34.3 and 77.3 µm. In addition, we classified the sizes of 4.47 µm by centrifugal to those with 1.15 and 5.12 µm.

Copper particles with 1.15, 4.47 and 5.12 µm produced greater cellular toxicities, considering the decrease in the cell viabilities rather than 26.1, 34.3 and 77.3 µm ($p < 0.05$). The results demonstrated that size distribution of aerosol and surface area are key parameters for the extent of PM toxicity, particularly in the case of the smaller particles. This method can be useful to investigate the toxicity for ambient air particles in terms of physicochemical properties.

3HA.3

Ambient Particle Composition and Toxicity in 31 Major Cities in China. LU ZHANG, Maosheng Yao, *Peking University*

Current air quality assessment or control effectiveness is solely based on particulate matter (PM) mass levels, failing to consider their toxicity differences in terms with health benefits. Here, we collected a total of 465 automobile air conditioning (AC) filters from 31 major Chinese cities to study the composition and toxicity of PM at a national scale in China. Our results showed that normalized PM toxicity (NIOG) varied greatly up to 6.5 times difference with 31 cities, and was shown to correlate significantly with annual PM10 concentration, total fungi, SO42- and calcium element. The levels of chemical and biological components in PM were closely associated with some meteorological factors and gaseous pollutants such as SO2. Toxicity-adjusted PM levels are very different from pure mass levels especially for 55 µg/m3 and higher. Integrating toxicity factor, city-specific air pollution control strategy thus should be enacted to maximize health and economic co-benefits.

3HA.4

Evaluation of PM2.5-induced Antioxidant Consumption and ROS Generation as a Proxy for the Aerosol Toxicity. SUDHEER SALANA, Yixiang Wang, Vishal Verma, *University of Illinois at Urbana-Champaign*

It is widely believed that antioxidants are primarily reactive oxygen species (ROS) scavenging molecules. Consequently, a number of assays have been developed to measure the rate of depletion of key cellular antioxidants such as glutathione and ascorbate, as a proxy for the ambient $PM_{2.5}$ oxidative stress and subsequent toxicity. However, depletion of some of these antioxidants such as reduced glutathione (GSH) is not limited to its reaction with ROS. So far, very few studies have explored the relationship between antioxidants consumption, ROS generation and cytotoxicity induced by ambient $PM_{2.5}$. We evaluated this relationship using a large number of ambient $PM_{2.5}$ samples (N=230) collected in Mid-West USA. We investigated the association between cell viability, GSH consumption and ROS response for A549 cells, by exposing the cells to the water extracts of $PM_{2.5}$ samples. Our results show that there is a good correlation between cell viability and ROS response (r >0.5). However, both ROS response and cell viability were poorly correlated (0.11<r<0.41) with the GSH consumption (measured via both cellular as well as acellular methods). Finally, we pre-treated the cells with GSH and measured the intracellular GSH depletion, cellular ROS generation and cytotoxicity, caused by $PM_{2.5}$ extracts. Interestingly, pre-treating the cells with GSH resulted in a substantial decrease (>50 %) in both ROS response and cell death. These results indicate that although GSH is involved in eliminating ROS and protecting the cells from $PM_{2.5}$ toxicity, measuring GSH consumption alone cannot be considered a surrogate for the $PM_{2.5}$ induced cytotoxicity and cellular oxidative stress. This is probably because $PM_{2.5}$ might induce glutathione depletion through other mechanisms beside ROS generation. Nevertheless, our results show that $PM_{2.5}$-induced cellular ROS measurement is still a biologically relevant parameter to represent cellular oxidative stress and cytotoxicity.

3HA.5

Effects of Acidity and Photoirradiation on Reactive Oxygen Species Formation from Secondary Organic Aerosols.

Jinlai Wei, Ting Fang, MANABU SHIRAIWA, *University of California, Irvine*

Reactive oxygen species (ROS) play a critical role in the chemical transformation of atmospheric secondary organic aerosols (SOA) and aerosol health effects by causing oxidative stress in vivo. Acidity is an important physicochemical property of atmospheric aerosols affecting numerous environmental processes. Meanwhile, photochemical aging is at the core of atmospheric aging processes, which is essential for the heterogenous chemistry of SOA. Despite the importance of acidity and photochemistry, their effects on the ROS formation from SOA have been poorly characterized. By applying the electron paramagnetic resonance (EPR) spin-trapping technique and the Diogenes chemiluminescence assay, we find highly distinct radical yields and composition at different pH in the range of 1 – 7.4 from SOA generated by oxidation of isoprene, α-terpineol, α-pinene, β-pinene, toluene and naphthalene. We observe that isoprene SOA have substantial hydroxyl radical (·OH) and organic radical yields at neutral pH, which are 1.5 – 2 times higher compared to acidic conditions in total radical yields. Superoxide (O2·-) is found to be the dominant species generated by all types of SOA at lower pH. At neutral pH, α-terpineol SOA exhibit a substantial yield of carbon-centered organic radicals, while no radical formation is observed by aromatic SOA. Further experiments with model compounds show that the decomposition of organic peroxide leading to radical formation may be suppressed at lower pH due to acid-catalyzed rearrangement of peroxides. For photochemistry, we combined an in-situ UV-vis irradiation system with EPR spectroscopy to characterize the photolytic generation of free radicals from SOA generated by isoprene, α-terpineol, α-pinene and toluene. We observe substantial formation of organic radicals (yields 0.02 – 1.5%) with enhancement factors up to ~ 100 compared to dark conditions. Total peroxide measurements elucidate that the peroxide fractions decrease 50 – 70% after irradiation, indicating organic peroxides as a potential source of organic radical formation. These findings are critical to bridge the gap in understanding ROS formation mechanisms and kinetics in atmospheric and physiological environments, as well as the photoinduced aqueous phase chemistry of SOA involving radical formation.

3HA.6

Measuring Reactive Oxygen Species (ROS) Production of Particulate Matter through Air-Blood Barrier Array Module.

SEONGBIN JO, Hannah Viola, Liang-Hsin Chen, Taekyu Joo, Shuichi Takayama, Nga Lee Ng, *Georgia Institute of Technology*

Expsoure to particulate matter (PM) causes a significant impact on human health. Many toxicological studies have examined various biological endpoints to study the adverse effects of PM exposure linked to respiratory diseases. However, their physiological relevance to human health and the inhibitory concentrations remain unclear. Furthermore, the extraordinary diversity in chemical properties and components of different ambient PM samples would lead to varied cellular responses from the PM exposure. Here, we introduce a newly-developed high-throughput air-blood barrier array (ABBA) module, which mimics the human lungs epithelium and endothelium interface that is capable of examining multiple cellular responses from exposure to PM samples. The air-blood barrier between the air-side epithelium and the blood-side endothelium provides a realistic model of the alveoli and respiratory bronchioles. The barrier strengthened with the co-cultured epi/endothelial cells establishes decreased permeability and induces PM deposition in a similar way to that of the alveoli cells. We use the ABBA module to investigate PM-induced reactive oxygen species (ROS) production, which can initiate inflammatory cascades and lead to oxidative stress, thus contributing to chronic lung diseases. Various assay parameters (dosage, sample incubation time, trans-epithelial electrical resistance, etc.) are controlled prior to the exposure experiments. The capability of the ABBA is demonstrated via measurements of ROS production of the co-cultured cells upon exposure to ambient PM samples collected in urban Atlanta. Dose response results will also be presented and discussed. The high-throughput ABBA module demonstrates the replicability and multiplicity for evaluating cellular responses upon aerosol exposure.

3PC.1 (Invited)

Connecting the Hygroscopicity, Viscosity and Water Diffusivity of Internally Mixed Organic-Inorganic Aerosol.

JAMES F. DAVIES, Craig Sheldon, Jack Choczynski, Chelsea Price, Katie Morton, Ryan Davis, *University of California, Riverside*

Internally mixed aerosol particles containing organic molecules and inorganic salts are prevalent in the atmosphere, arising from direct emission (e.g. from the ocean) or indirect production by condensation of organic vapors onto existing inorganic particle seeds. Aerosol particles co-exist with water vapor and, under humid conditions, will exist as dilute aqueous solution particles. As the humidity decreases, water is lost and the solute concentration increases, leading to significant changes in particle properties and morphology.

In this work we explore model aerosol particles containing inorganic salts, such as ammonium sulphate, mixed with oxygenated organic molecules. Using single particle levitation, we measure the hygroscopicity, viscosity, and rate of water transport in particles across a range of RH conditions and organic mass fractions. These properties are responsible for controlling many important physical and chemical aerosol processes in the atmosphere and are connected by their dependence on RH. We report the RH-dependence of these properties and explore the applicability of commonly used methods that connect them together, such as volume-additivity relations, the Stokes-Einstein relationship, and thermodynamic modelling methods.

3PC.2

The Effect of Particle Phase and Morphology on Its Evaporation Kinetics and Rates of Heterogeneous Reactions.

ALLA ZELENYUK, Jacqueline Wilson, Kaitlyn Suski, ManishKumar Shrivastava, *Pacific Northwest National Laboratory*

The properties and behavior of mixed aerosols particles depend on their phase and morphology. In particular, the rates of heterogeneous reactions strongly depend on whether the condensed-phase reacting substances are on the particle surface or inside the particle, behind a protective shell.

We demonstrated the ability to generate size-selected particles with tailored morphologies and to characterize their three-dimensional structures utilizing our “depth-profiling” approach, in which by controlling laser fluence, we control the depth to which the laser penetrates the particle. At low laser fluence, the surface compounds dominate the single particle mass spectra, and at high fluence, the mass spectra represent the composition of the entire particle. This approach was successfully applied to characterize morphology of NaCl seeds coated with solid pyrene and with liquid dioctyl phthalate (DOP), NaCl particles coated by secondary organic aerosol (SOA) formed by ozonolysis of α-pinene, SOA-coated DOP particles, and DOP-coated SOA particles, revealing their complex layered morphologies.

We will present the results of a recent study, in which we prepared particles containing SOA formed by oxidation of different precursors and condensed on pre-existing size-selected seed particles with different compositions, viscosities, and volatility (different SOA material, oleic acid, DOP, and polyaromatic hydrocarbons), characterized their morphology, and investigated the effects of SOA coating thickness, and viscosity on the rates of heterogeneous reactions, evaporation kinetics, and particle coalescence.

We find, for example, that the viscous semi-solid SOA coatings can impede evaporation of more volatile organic seed particles. Similarly, our data show that SOA coatings of oleic acid particles significantly reduces the rate of their heterogeneous oxidation by ozone.

3PC.3

Molecular Dynamics Simulations of the Microphysics of Liquid Water in Nano-aerosol Droplets. XIAOHAN LI, Ian Bourg, *Princeton University*

Ultrafine aerosol particles with sizes smaller than 50 nm have been shown in recent studies to serve as a large source of cloud condensation nuclei (CCN) that can promote additional cloud droplet formation under supersaturation condition. Investigation of the microphysics of liquid water in such droplets remains arduous, particularly in the sub-10 nm particle size range, due to experimental and theoretical challenges associated with the complexity of aerosol components and the small length scales of interest (e.g., difficulty of precisely sampling the liquid-air interface, questionable validity of mean-field theoretical representations). Here we carried out molecular dynamics (MD) simulations of aerosol particles with diameters between 1 and 10 nm and characterized atomistic-level structure and water dynamics in well-mixed and phase-separated system with different particle sizes, NaCl salinities, and organic surface excess values as a function of distance from the time-averaged Gibbs dividing interface or instantaneous water-air interface. We use a sphericity factor developed in this study to quantitatively represent the phase-mixing state of nanodroplets and characterize its strong dependence on droplet size. Our study also evidences and quantifies an ion concentration enhancement in ultra fine aerosols, which suggests a size-dependence to salt nucleation kinetics in ultrafine sea salt aerosols, and provides detailed characterization of the influence of droplet size on surface tension and on water self-diffusivity near the interface. Besides, analysis of water evaporation free energy and water activity demonstrates the validity of Kelvin equation and Köhler theory at droplet sizes larger than 4 nm under moderate salinities and organic loadings and the need for further extension to account for ion concentration enhancement of sub-10 nm aerosols, droplet-size-dependent phase separation effects, and the sharp variation of surface tension of sub-4 nm droplets. Finally, we use the surface coating factor defined in this study to categorize and reconcile the water accommodation coefficient results from MD simulations and experiment results, and resolve the size dependence and its relationship to chain-structured organic coatings.

3PC.4

Parameterization of Aerosol Size of Organic and Secondary Inorganic Aerosol for Efficient Representation of Global Aerosol Optical Properties. HAIHUI ZHU, Randall Martin, Betty Croft, Shixian Zhai, Liam Bindle, Inderjeet Singh, Jeffrey R. Pierce, Chi Li, Deepangsu Chatterjee, *Washington University in St. Louis*

Accurate representation of aerosol optical properties is essential for modeling and remote sensing of atmospheric aerosols. Although aerosol optical properties are strongly influenced by the aerosol size distribution, atmospheric models seldom use an aerosol microphysics scheme because of the computational demand. Computationally efficient parameterizations are needed. In this study, aircraft measurements over the United States (DISCOVER-AQ) and South Korea (KORUS-AQ), are interpreted with a global chemical transport model (GEOS-Chem) to investigate the variation in aerosol size when organic matter (OM) and sulfate-nitrate-ammonium (SNA) are the dominant components. Measurements exhibit a strong correlation (r = 0.82) between aerosol size and the sum of OM and SNA mass (M_{SNAOM}). A global microphysical model (GEOS-Chem-TOMAS) simulation indicates that M_{SNAOM}, and the ratio between the two components (OM/SNA) are the major indicators for SNA and OM aerosol size. A parameterization of effective radius (R_{eff}) for SNA and OM aerosol is proposed, which is highly consistent with GEOS-Chem-TOMAS simulated Reff ($R^2 = 0.72$, slope = 0.99). Thus, this parameterization offers a computationally efficient method to represent aerosol size in atmospheric models.

3PC.5

Particulate Matter Collected in an Impactor from a Euro VI Diesel Engine on Real-world Conditions: Physicochemical Characterization. Camilo Zapata-Hernandez, Camilo Bernal, KAREN CACUA, *Instituto Tecnológico Metropolitano de Medellín*

Diesel engines are big contributors to air pollution and are important to identify their health impacts associated with their size, morphology, and chemical composition. In this study, Particulate Matter (PM) emission from a euro VI diesel engine from several euro VI diesel engines working with a blend of diesel and biodiesel (10 % vol.) was collected in a cascade impactor and classified into 14 size fractions. The size range of the particles was less than 10 µm. PM morphology and chemical composition were characterized by scanning electron microscopy (SEM) and energy-dispersive x-ray spectroscopy (EDS) analysis for each size fraction, respectively. Additionally, Fourier infrared spectroscopy (FTIR) and thermogravimetric analysis (TGA) were used to identify the functional groups and their thermal behavior, respectively. Results show that particle morphology is quasi-spherical and their main component is carbon, also, with some traces of metals. Additionally, functionalities associated with alkyl aromatic hydrocarbons were identified.

3PC.6

Turbulent Flux Measurements and Transfer Velocity Estimates of Nucleation-sized Particles. NICHOLAS MESKHIDZE, Ajmal Rasheeda Satheesh, Sabin Kasparoglu, Mohammad Maksimul Islam, Bethany Sutherland, Markus Petters, *NC State University*

The eddy-covariance flux measurements of >3 and >10 nm particles were conducted at the DOE ARM SGP site in Oklahoma. The main objective of the field campaigns was to examine the feasibility of measuring particle fluxes to distinguish between ground-level and residual-layer New Particle Formation (NPF) events. Equipment deployed included a 10-m telescopic tower, multiple condensation particle counters, a sonic anemometer, a scanning mobility particle sizer (SMPS), a Printed Optical Particle Spectrometer, and a humidified tandem differential mobility analyzer. Our measurements were supplemented by the ancillary data obtained from the ARM facilities, such as radiosondes, Aerosol Observing System SMPS and nano-SMPS, vertically pointed Doppler Lidar, and the University of Wisconsin High Spectral Resolution Lidar.

Here we show that when 3-10 nm-sized particles appear at the ground level, the derived flux signs are representative of the directional transport of particles: the negative fluxes indicate downward transport, i.e., the NPF happens aloft, while the positive fluxes denote upward transport, i.e., the NPF occurs near the surface. Hygroscopic growth factor measurements for 15, 20, 30, 40, and 50 nm-sized particles indicated growth factors much smaller than those of ammonium sulfate, suggesting that organic compounds dominated the sub-50 nm sized particle chemical composition. Flux measurements also allowed us to examine 3-10 nm-sized particle dry deposition velocity. Although both the positive and the negative values of the deposition velocity inferred in this study are comparable to the values reported in the literature, we argue that the methodology for calculation of the deposition velocity (assuming zero particle concentration very near the surface, at the top of the diffusion sublayer) is inadequate for the estimation of sub-10 nm particle deposition velocities in most environments.

A similar eddy-covariance flux measurement setup will be deployed during the TRACER campaign and we anticipate showing the first results.

3UA.1

Ground-based Particulate Matter Monitoring Network for NASA’s Multi-Angle Imager for Aerosols (MAIA) Investigation: Development Status and Preliminary Results.

SINA HASHEMINASSAB, David Diner, Araya Asfaw, Jeff Blair, Ann Dillner, John Hall, Brent Holben, Richard Kleidman, Yang Liu, Christian L'Orange, Randall Martin, Brenna Walsh, *Jet Propulsion Laboratory*

NASA’s Multi-Angle Imager for Aerosols (MAIA) investigation, currently in development for launch later this decade, aims to enhance our understanding about the impacts of exposure to ambient particulate matter (PM) and its major chemical constituents on human health. The MAIA satellite instrument– a multi-angle imaging spectropolarimeter– will collect targeted measurements of column-integrated aerosols microphysical properties, which will be integrated with measurements from a network of ground-based PM monitors and outputs of the WRF-Chem atmospheric model in order 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. The main focus of the MAIA investigation is a selected set of Primary Target Areas (PTAs) covering highly populated metropolitan regions distributed around the world. This presentation will describe the ground-based PM monitoring component of the MAIA project, provide an update on its development status, and present preliminary results collected thus far across different PTAs.

Where available, MAIA project collects data from existing ground-based PM monitoring networks managed by government agencies, research groups, and other sources. In several PTAs, the MAIA project is capitalizing on existing SPARTAN Surface Particular Matter Network for $PM_{2.5}$ speciation and expanding this network with additional filter samplers; deploying Aerosol Mass and Optical Depth (AMOD) to complement $PM_{2.5}$ speciation networks; and installing AethLabs microAeth MA350 monitors for black carbon measurements in heavily polluted regions. The AMOD units are also equipped with a light-scattering PM sensor and an aerosol sunphotometer and their data may be used outside of the routine MAIA operation for regression training and validation purposes. In Ethiopia, where only a few total $PM_{2.5}$ monitors have historically been operating, a set of cost-effective PurpleAir sensors has been deployed to enhance the spatial coverage of ground-based $PM_{2.5}$ measurements. Sun and sky scanning radiometers have also been installed in several PTAs as part of the Aerosol Robotic Network (AERONET) to serve as pre-launch proxies for MAIA aerosol information.

3UA.2

Design and Development of a Multi-Metal Mobile Platform (MMMP): Status Update and Preliminary Results.

MOHAMMAD SOWLAT, Steven Boddeker, Avi Lavi, Christopher Lim, Sina Hasheminassab, Faraz Ahangar, Julia Montoya-Aguilera, Pami Mukherjee, Jamie Berg, Payam Pakbin, Andrea Polidori, *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, especially in disproportionately impacted (i.e., Environmental Justice (EJ)) communities. Mobile monitoring techniques are a potential solution, as they enable capturing of the spatial variations of the target pollutant(s) within a short period of time. In this study, we developed a novel platform for mobile monitoring of multiple ambient particulate metals using an optimized X-Ray Fluorescence- (XRF) based instrument. The instrumentation aboard the platform also enables the measurement of aerosol characteristics, including size-resolved (0.253-35.15 µm) particle mass and number, total particle number concentration (PNC), and black carbon (BC); trace gases, including NO2 and CO2; and meteorological parameters, including wind speed and direction; all in fine time resolutions (seconds to minutes). Previously, we presented an overview of the design criteria, features, and characterization of the platform. In this presentation, we provide an update on its development status, discuss challenges encountered, and delineate a comprehensive strategy for the application of the MMMP for both mobile and stationary monitoring. We also present preliminary results of the field application of the MMMP and demonstrate how it can be used for concentration mapping, source identification, and source characterization.

3UA.3

In-vehicle Ultrafine Particles Exposure Measurements in a South Asian Mega City: Dhaka, Bangladesh. Shaikh Ashik-Un-Noor, Mustafizur Rahaman, Albert Presto, PROVAT SAHA, *Bangladesh University of Engineering & Technology*

We measured and compared in-vehicle ultrafine particle concentrations in common transportation modes in Dhaka city of Bangladesh. In-vehicle measurements of particle number concentration (PNC; a measure of ultrafine particles) were collected in public buses, private cars, and rickshaws. In-car measurements were collected under (i) window-open, (ii) window-closed and air-recirculation 'off', and (iii) window-closed and air-recirculation 'on' conditions. For each case, about ten days of repeated measurements were collected on a selected 15-km route covering different times of the day (morning, mid-day, and afternoon). Results indicate that in-vehicle PNCs vary by transportation mode, higher in the public bus and substantially lower for the private cars under window-closed and air-recirculation 'on' conditions. The inter-modal variation is about a factor of two. In all modes, in-vehicle PNCs are substantially higher than the urban background level; about 4-8 times higher in public buses and 2-4 times higher in private cars with window-closed and air-recirculation 'on'. Substantially higher in-vehicle PNCs and their inter-modal variations have implications on PNC personal exposures. About 1-2 hours of commuting time (4-8% of daily hours) contribute to 15-35% of daily exposure. Exposures are higher for public bus commuters and lower for private car commuters, specifically, those who commute under window-closed and air-recirculation 'on' conditions. This study's results could help design appropriate mitigation measures for reducing personal exposure to ultrafine particles.

3UA.4

PM2.5 Sensor Intercomparisons and Regional Trend Assessments from Low-Cost Sensor Networks in Accra, Ghana and Lomé, Togo. GARIMA RAHEJA, Emmanuel Appoh, Ebenezer Appah-Sampong, Maxwell S. Sunu, John K. Nyante, Allison Felix Hughes, Celeste McFarlane, Rob Pinder, Stefani Penn, R. Subramanian, Michael Giordano, Levi Stanton, Daniel Westervelt, *Columbia University*

Metropolises in sub-Saharan Africa experience high levels of ambient air pollution, but remain scarcely measured by reference-grade monitors. We combine insights from three years of data collected by Purple Air and Clarity sensor networks, with newly developed correction factors for low-cost sensors in this region based on collocation with reference monitors.

For Accra, Ghana, we utilize a network of 18 Clarity (low-cost) sensors deployed since August 2018 to analyze regional trends, and assess the reductions in $PM_{2.5}$ caused by clean air interventions as well as the COVID19 pandemic. We find that calibrated daily averaged $PM_{2.5}$ is 26.4 µg m^{-3} (within the EPA Ghana standard for 24-hour mean of 35 µg m^{-3}). On average 94.8% of days exceed the WHO daily standard.

In Lomé, Togo, our 5-node PurpleAir network deployed in 2019 represents the first ever long-term ambient $PM_{2.5}$ measurements in the city to our knowledge. We find the daily $PM_{2.5}$ average is 23.5 µg m^{-3} (1.5 times the WHO daily average guideline of 15 µg m^{-3}). In Accra and Lomé, sensor sites show diurnal patterns with morning peaks 2.5 times stronger than evening peaks (with notable exceptions linked to areas with intense rush hour traffic jams), as well as annual patterns with mean $PM_{2.5}$ concentrations 1.5 times higher during the Harmattan period. At all sites, more than 87% of measured days surpass WHO $PM_{2.5}$ Daily Guidelines.

Finally, we present the results from one year of intercomparison between various low-cost (PurpleAir, Clarity, MODULAIR) monitors and reference-grade (BAM-1020, Teledyne T-640) monitors. We find that Clarity monitors show the best correlation with reference-grade monitors, with R^2 = 0.76 and Mean Absolute Error = 3.36 µg m^{-3}. This intercomparison research contributes to our development of globally-applicable models for calibrating and correcting low-cost sensors.

[1] https://pubs.acs.org/doi/full/10.1021/acsearthspacechem.1c00217
[2] https://pubs.acs.org/doi/10.1021/acsearthspacechem.1c00391

3UA.5

Love My Air PM2.5 Sensor Network Analysis. TEHYA STOCKMAN, Aubrey Burgess, William Obermann, Brendan Lawlor, Shelly L. Miller, *University of Colorado Boulder*

The Love My Air Network is a network of low-cost PM2.5 sensors (Plantower, Lunar Outpost and Clarity Inc.) placed outside of schools across Denver, Colorado. This network started in 2018 and has continued to expand as more schools have been added to the Love My Air program; there are approximately 40 sensors in the network as of early 2022. In addition, the network has collocated sensors at five federal equivalent method (FEM) air monitoring stations in Denver. Data from one collocated sensor has been used to calibrate the sensor network. Schools are invited by the Denver Department of Public Health and Environment (DDPHE) to participate in the Love My Air program based on a variety of factors including: asthma rate, free-and reduced lunch rate, and school readiness. Many of the schools with PM2.5 sensors are located in environmental justice communities. Among the schools in this network, some are located close to major roadways, while others are close to larger green spaces. This research analyzes the variation in PM2.5 across the sensor network in Denver from 2018 to 2022 and the relationship between PM2.5 measured outside of schools and the distance to major roadways.

3UA.6

Wintertime Spatial Patterns of Particulate Matter in Fairbanks, AK during ALPACA 2022. ELLIS ROBINSON, William Simpson, Peter F. DeCarlo, *Johns Hopkins University*

Fairbanks-North Star Borough (FNSB), Alaska perennially experiences some of the worst winter-time air quality in the United States. FNSB was labeled a ''serious'' nonattainment area by the EPA in 2017 with respect to fine particulate matter ($PM_{2.5}$). The ALPACA (Alaskan Layered Pollution And Chemical Analysis) field campaign was established to better understand the sources of air pollution, pollutant transformations, and the meteorological conditions contributing to FNSB's air quality problem. We performed on-road mobile sampling during ALPACA to identify and understand the spatial patterns of PM across the study domain, which contained multiple stationary field sites.

These measurements demonstrate the following results, which are important both for the PM exposure of residents of FNSB and the spatial context of the ALPACA study: 1.) Both the between-neighborhood and within-neighborhood variations in $PM_{2.5}$ concentrations and composition are large (>10 $\mu g\ m^{-3}$). 2.) Spatial variations of PM in Fairbanks are tightly connected to meteorological conditions; dramatic between-neighborhood differences exist during stark temperature inversion conditions, but are significantly reduced when atmospheric conditions are more stable. 3.) During inversion conditions, total $PM_{2.5}$ and black carbon (BC) are tightly spatially correlated and have angstrom exponent values (AAE > 1.4) indicative of woodsmoke, but are relatively uncorrelated during stable conditions, implying that much of the spatial differences in PM are driven by the interplay between local emissions of woodsmoke and meteorology. 4.) $PM_{2.5}$, BC, and total particle number (PN) concentrations decreased with increasing elevation, with the fall-off being more dramatic during strong temperature inversion conditions. 5.) Lastly, mobile sampling reveals important air pollutant concentration differences between the multiple fixed sites of the ALPACA study, and demonstrates the utility of adding mobile sampling to better understand the spatial context of large urban air quality field campaigns.

4MJ.1

Jayashree Yalamanchili, PhD Candidate, University of Maryland, Baltimore County. JAYASHREE YALAMANCHILI, *University of Maryland, Baltimore County*

I am currently a Ph. D. candidate in Chemical Engineering at the University of Maryland, Baltimore County, under the guidance of Drs. Chris Hennigan and Brian Reed. My Ph.D. research investigates the fate of transition metals in phosphate-based acellular assays that measure the oxidative potential (OP) of different species in particulate matter. My skills and experience include: (1) thermodynamic equilibrium modeling using MINEQL and MINTEQ, (2) metal precipitation experiments in the dithiothreitol (DTT) assay, which leverage colorimetric analyses, inductively coupled plasma spectrometry (ICP-MS), laser particle light scattering measurements, UV-Vis spectrophotometry, and other laboratory activities. I have data analysis and computational experience with SPSS software, Microsoft Excel, MATLAB, and Igor.

In addition to modeling, conducting lab experiments, and data analysis, I have mentored several undergraduate students. Further, my previous research projects were focused on a low-cost PM sensor, ocean thermal energy conversion (OTEC) plant design and development, and carbon-dioxide mineral sequestration.

My expected graduation is December 2022. I am interested in research opportunities in the industry, government, or academic institutions. I do not have any geographical limitations.

Email: jyala1@umbc.edu

4MJ.3

Tania Gautam, PhD Candidate Pursuing Industry/Government Postdoctoral Positions, Preferred Location: Colorado. TANIA GAUTAM, *University of Alberta*

I am a 4th year PhD student in the department of analytical chemistry at the University of Alberta (U of A) in Dr. Ran Zhao's group. Spectroscopic methods are often employed for selective and quantitative determination of organic peroxides in any given matrix. My recently published work investigated potential matrix interferences in iodometry, which remains one of the most pursued methods for quantification of total peroxides in any given matrix. The work in my 2nd project is an extension from the first project, focusing on application of advanced analytical techniques in determining elusive reactive intermediates such as organic peroxides through novel formation pathways. My 3rd project is based on acquiring qualitative and quantitative detection of olefinic species in indoor environments. In particular, cooking aerosols from highly unsaturated edible oils will be investigated by probing into reaction kinetics of precursor compounds and halogens.

While I was an undergraduate student at U of A, I had amazing internship opportunities at industrial (ALS Global, 2016) and governmental (National Research Council, 2018) institutions. Through this work experience, I have gained hands-on experience in analytical instrumentation including operation/maintenance. I am equipped at data management using software analysis with Igor Pro. Given my background in chemistry, I am looking forward to exploring the application of analytical techniques in determination of organic pollutants such as perfluoroalkyl compounds in drinking water and determining their fate through fundamental studies. Over the last decade, PFAS have received tremendous attention due to their persistence and I wish to contribute my knowledge towards targeted analysis of PFAS in drinking water. My anticipated graduation is December 2023 and I will be available for full time positions starting January 2024 for companies located within North America. Please contact me at tgautam@ualberta.ca

4MJ.4

Ravleen Kaur, PhD Candidate (Analytical Chemistry), Analytical Characterization and Method Development in R&D. RAVLEEN KAUR KOHLI, *University of California, Riverside*

My name is Ravleen Kaur, and I am a PhD candidate at UC Riverside (UCR), planning to graduate by November 2022. I am a multi-disciplinary researcher with specialization in analytical chemistry and significant knowledge in high resolution mass spectrometry. I am currently seeking roles related to analytical characterization and method development in R&D, in and around Southern California.

My doctoral research at UCR focuses on development and utilization of laboratory-based analytical techniques for levitating single particles and probing their properties and composition using optical spectroscopy coupled to mass spectrometry. Results of these studies are used to make qualitative and quantitative predictions to understand the fundamental role of aerosols in air quality, health, and industrial implications. Throughout my PhD, I have led research projects and trained colleagues on utilization of analytical instrumentation. My contributions have led to numerous research publications, including my own 3 first-author publications. I was also awarded a master’s degree for the coursework completed during my doctorate.

Prior to enrolling at UCR, I worked in various research roles at CSIR-National Physical Laboratory (NPL). I started my career as a Research Intern where I gained experience on multiple analytical techniques, such as AAS, UV-Vis and gravimetric analysis. I demonstrated excellent research skills and received a Diamond Jubilee Research Intern Award to work as research assistant in which I was a part of metrology group. I co-led preparation of certified gas reference materials and calibration solutions, and their testing using techniques like GC-FID and ICP-OES. I was also selected to be a part of collaboration with PTB, Germany and secured an Overseas Federal Grant Fellowship in Germany.

Based on my outstanding performance, I was offered a second promotion to Research Associate in less than 24 months. As Research Associate, I performed air quality measurements and conducted rigorous testing of drinking water samples. In addition, I was responsible to review and maintain chemical inventory, SOP, and SDS documentation.

These research experiences allowed me to practice strong communication, teamwork, and leadership skills. I also developed meticulous attention to detail, and project management abilities, which have been enhanced during my time at UCR. These research roles have broadened my skill set and prepared me well to transition to a role in scientific industry.

4MJ.5

Chun-Ning Mao, Graduate Assistant/PhD Candidate Looking for an Entry-level Engineering Job / Chemical Engineering. CHUN-NING MAO, *University of Maryland*

Chun-Ning Mao is currently a PhD candidacy at University of Maryland looking for an entry-level engineering job. In 2017, she earned a bachelor degree in Chemical Engineering from National Taiwan University. From 2017 July to 2018 May, she worked as a research assistant in Taiwan DuPont at Hsin-Chu EKC Department. Later she joined the PhD program in Department of Chemical and Biomolecular Engineering at University of Maryland till now. She is a lab member of Environmental Aerosols Research Lab (EARL) group from Dr. Asa-Awuku. Her research interests include but not limited to the hygroscopicity of polymeric aerosols, cloud condensation nuclei studies, nano-particles adsorption and nano-plastics generation. She planned to graduate in 2023, May, and is looking for an entry-level engineering related job in the Maryland or Washington metropolitan area.

4MJ.6

Madeleine Petersson Sjögren, PhD Student in Aerosol Technology, Lund University, Sweden, Looking for a Post-doctoral Position or Science Communication Work.
MADELEINE PETERSSON SJÖGREN, *Lund University, Sweden*

I hold a Master of Science in physics and I'm currently in the last year of my PhD studies in Aerosol Technology. In my research I do measurements on nanoparticle lung deposition in humans to study particle transport and deposition mechanisms in human lungs. The goal of these measurements is to explore if we can estimate the size of peripheral lung airspaces by measurement of nanoparticle lung deposition. Ultimately, we hypothesize that these measurements can be used for detection of lung disease. I am part of an interdisciplinary research group where my main responsibilities combine data analytics, optimization of calculations to derive parameters from experiments, statistical analysis, and writing. I work together with many other physicists and engineers, as well as medical personnel. As a side project I do measurements and analyses of atmospheric fluorescent bioaerosols with the aim to understand which factors that are crucial for the generation and spread of atmospheric bioaerosols.

I will be finishing my PhD by March 2023 and I will then be available for future opportunities. My main interests are within the combination of aerosol science and data analytics. I enjoy learning new methods and techniques, and to apply statistical analysis. I'm passionate about science communication and I enjoy academic as well as popular science writing a lot. I have no geographical preference for my future position, but I look forward to exploring new places and environments.

4MJ.7

Cheryl L. Weyant, Postdoctoral Researcher. CHERYL WEYANT, *University of Michigan*

Cheryl is an interdisciplinary air pollution scientist and is currently a postdoctoral researcher at the School for Environment and Sustainability at the University of Michigan. Her research centers around combustion technologies for household and industrial energy. For her PhD, she conducted field studies to characterize aerosol emissions and their climate effects, focusing on household biomass cooking, kerosene lighting, industrial brick-making, and gas flaring. When she stepped back from these smoky plumes, she could see that there was a complicated human landscape connected to each of these technologies. So, now she is delving into the field of economics to research how combustion technologies are being used by people, what drives change, and how these transitions impact pollutant exposure. In her future research, she hopes to use her interdisciplinary background to study the intersection between energy transitions and climate change; how does a changing climate constrain energy transitions and how do these transitions impact emissions that cause climate change? How is pollution exposure impacted by these dynamics? She's interested in growing her range of research tools to include satellite image analysis and modeling. She's looking for an academic research position, postdoc, or other research-centered positions outside of the academy.

4MJ.8

Nirvan Bhattacharyya, PhD Candidate, University of Texas at Austin - Seeking a Postdoctoral Research Position. NIRVAN BHATTACHARYYA, *University of Texas at Austin*

I work at the University of Texas at Austin with Professor Lea Hildebrandt Ruiz on indoor and outdoor air chemistry and aerosol formation. My work has focused on the impact of chlorine though several studies: 1) chamber experiments on m-xylene oxidation by Cl and OH radicals to examine the influence of oxidative environment on gas and particle phase products; 2) field deployment in an oil and gas production region of a novel chlorine oxidative flow reactor (Cl-OFR) developed by Aerodyne Research, Inc. to study atmospheric aging; 3) parallel and sequential Cl-OFR and chamber oxidation of anthropogenic (m-xylene, ethylbenzene, D5 siloxane) and biogenic (isoprene, limonene, α-pinene) species to evaluate each oxidation method; and 4) bleach disinfection experiments to assess interaction with masks during COVID-19 in collaboration with Professors Novoselac and Misztal (UT Austin). In these laboratory and field studies, I have operated and analyzed data from a time of flight, chemical ionization mass spectrometer with filter inlet for particle analysis (FIGAERO-CIMS), Vocus proton transfer reaction mass spectrometer (Vocus PTRMS), aerosol chemical speciation monitor (ACSM), scanning electrical mobility system (SEMS), and a variety of gas phase monitors.

I anticipate defending my dissertation by April 2023 and could begin postdoctoral research as early as May 2023. Moving forward, I would like to utilize my knowledge of high-resolution mass spectroscopy while developing new skills around modeling and statistical analysis. I am interested in field and laboratory work, with a particular interest in projects that work directly with communities underserved by existing air monitoring and research. I have no geographical preferences and am open to positions in the US and internationally.

4MJ.9

Mariah Gnegy, Ph.D. Candidate at Virginia Tech Seeking Government or Industry Positions. MARIAH GNEGY, *Virginia Tech*

I am a Ph.D. candidate at Virginia Tech in the Department of Civil and Environmental Engineering with an expected graduation date of December 2022. I also have a graduate certificate in public health from Virginia Tech. I am primarily interested in government or industry positions, and I do not have a geographical preference.

My dissertation research has focused on human interactions with microorganisms in the built environment. My work has consisted of three projects: (1) evaluating the potential of probiotic surface cleaning products, (2) assessing the impact of a barrier on the distribution of simulated respiratory particles in an enclosed room and (3) estimating inhalation risks associated with airborne viruses originating from wastewater. The first project investigated the impact of relative humidity on spore viability via culturing. The second project involved the design and construction of a room to collect aerosolized fluorescent particles with and without a barrier via fluorescent microscopy. For the third project, I am currently collecting wastewater and air samples from a local WWTP and quantifying the aerosolization of viruses via qPCR and sequencing. This data is to be used in a quantitative microbial risk assessment model to estimate potential inhalation risks to WWTP employees. Other skills I have acquired throughout my dissertation include particle sizing (via APS), flow cytometry, and bioaerosol sampling.

I hope to expand my knowledge of the impact of bioaerosols on human health and continue to work at the nexus of environmental engineering and public health.

4MJ.10

Alyssa Alsante, Ph.D. Candidate Pursuing a Postdoctoral Research Position. ALYSSA ALSANTE, *Texas A&M University*

I completed a Bachelor of Science in Microbiology at the University of Tennessee, and I am currently a Ph.D. candidate with Dr. Daniel Thornton (advisor) in the Department of Oceanography and Dr. Sarah Brooks (co-advisor) in the Department of Atmospheric Sciences at Texas A&M University. My research interests include understanding the aerosolization and dispersal of microbes and their role in cloud formation and climate. My dissertation research is focused on characterizing sources of marine atmospheric ice nucleating particles (INPs). Specifically, I am investigating organic biomolecules as INPs such as amino acids, enzymes, and nucleic acids to better understand their composition. I have also conducted experiments using a marine aerosol reference tank to understand ice nucleation from different phytoplankton groups throughout the entire growth cycle and during a viral lysis event. I am now using more controlled and defined continuous-culturing methods to understand how physiological status affects ice nucleation. In the field, I have participated in small-vessel coastal research and large-vessel research for the North Atlantic Aerosols and Marine Ecosystems Study (NAAMES) to link seasonal phytoplankton changes with aerosol production. I collected aerosol impactor samples for ice nucleation analysis and assisted with aerosol instrumentation. My skillset includes growth and maintenance of microbial cultures and viruses, biomass and physiological status indicators, extraction and sequencing of nucleic acid, optical and epifluorescence microscopy, aerosol impactor sampling, ice nucleation analysis, and Raman spectroscopy. I currently have one first author and three co-author manuscripts published with an additional two in review and two in preparation manuscripts. I have had two platform presentations at academic conferences and one departmental seminar presentation. I am looking for an academic postdoctoral research position to continue research on aerosolized microbes and their role in ice-containing cloud formation. I anticipate graduating in Summer 2023 with a start date in Fall 2023.

4MJ.11

Ningjin Xu, Ph.D. Candidate at UC, Riverside. NINGJIN XU, *University of California, Riverside*

Bio: Ningjin Xu has MS in Chemical and Biomolecular Engineering from Case Western Reserve University and holds a Chemical Engineering in Training (EIT) license. She is currently a Ph.D. candidate in Chemical and Environmental Engineering at UC, Riverside. Her previous project focused on the design and characterization of a cost-effective oxidation flow system for laboratory and long-term ambient secondary aerosol processes. Her current projects focus on the development and application of a multiphase oxidation flow reactor for studying SOA formation through gas- and aqueous-phase OH oxidation of different volatile organic compounds. In the past year, she has been involved in a large ambient air quality project sponsored by California Air Resources Board (CARB), where she coordinated with fellow graduated researchers, and principal investigators to analyze the compositions and formation of ambient aerosols. Also, she has been involved in laboratory studies investigating the atmospheric chemistry and physicochemical properties of methylated selenium-derived aerosols and this project was funded by National Science Foundation (NSF).

Key interests: (i) Atmospheric Science (ii) Air pollution exposure (iii) Instrument designs and applications (iv) Field sampling and analysis

Key skills: (i) Design and construction experience of reactor systems for both laboratory studies and long-term air pollution measurement field campaigns. (ii) Setting up and operating range of air quality instrumentation. (iii) Proficient with required design programs such as LabVIEW, SOLIDWORKS, AutoCAD, COMSOL Multiphysics, etc. (iv) Experience with a variety of analytical instruments, such as SMPS, AMS, GC, TGA, NMR, FTIR, DSC. (v) Strong ability to plan and manage numerous processes and projects simultaneously.

Job types of interest: (i) Postdoc (aerosol, atmospheric chemistry, instrumentation) (ii) Industry or government (aerosol instruments, environmental-related work).

Geographical preference: U.S.

Preferred start date: Spring/Summer 2023

Contact: nxu018@ucr.edu

Note: Not a US citizen or permanent resident

4MJ.12

Brianna Hendrickson, Ph.D. Candidate Pursuing an Industry Career or Postdoctoral Research Position. BRIANNA HENDRICKSON, *Texas A&M University*

I am currently a fifth year Ph.D. Candidate in the Department of Atmospheric Sciences at Texas A&M University with Dr. Sarah D. Brooks. My research interests include aerosol, cloud condensation nuclei (CCN), ice nucleating particles (INPs), air-sea interactions with the sea surface microlayer (SML), aerosol instrumentation, pollen grain rupture, and dispersal of subpollen particles (SPPs). I have conducted research in the field for the NASA North Atlantic Aerosols and Marine Ecosystems Study (NAAMES). During these field campaigns, I led the operation of online aerosol instruments measuring aerosol concentration, size distribution, and cloud-forming properties as well as collection of aerosol filters and SML samples for offline analysis. With these measurements, I analyzed the role of SML properties in cloud formation. Currently, I am characterizing atmospheric conditions needed for pollen grain rupture, quantifying SPP emissions from a pollen grain, and determining the effects on human health and climate from pollen grains and SPPs. To address these objectives, I constructed a chamber to analyze various species of anemophilous plants. Environmental conditions were controlled inside the chamber with the plant to evaluate SPP release using instruments measuring the concentration of aerosol produced. Emission factors were then determined. Additional laboratory experiments examined the role of SPPs and pollen grains in ice nucleation. SPP emission factors and INP concentrations will be incorporated into a regional modeling framework to explore the potential for SPPs and pollen grains to influence health and cloud formation. I am anticipating graduation in December 2022. I am interested in working either in industry or in a postdoctoral research position. I am research focused and would continue experimentation and data collection during laboratory or field work. I am focused on finding an opportunity to work for an instrumentation company in research and development where my experience with aerosol instrumentation will be applicable.

4MJ.14

Job Seeker Abstract - Devon Higgins. DEVON HIGGINS, *University of Delaware*

My name is Devon Higgins, and I am a Ph.D. Candidate at the University of Delaware in Analytical Chemistry with a projected graduation date of spring 2023. My Ph.D. work is with Dr. Murray Johnston on several projects and collaborations investigating aerosol particle growth rates and their associated morphology and composition. I attended Le Moyne College in Syracuse, NY for my Bachelor’s degree in Chemistry where I worked with Dr. Anna O’Brien (Le Moyne College) and Dr. Karin Ruhlandt (Syracuse University) on a project that utilized air-sensitive techniques to synthesize Alkali and Alkaline-Earth organometallic complexes. Because of this strong foundation in air-sensitive synthesis and graduate work in analytical chemistry, I am an extremely detail-oriented chemist with a creative approach to problem solving. My graduate and undergraduate coursework, which also included minors in Mathematics and Environmental Science, was dedicated to learning as many new techniques and research methods as possible, including a field campaign to Costa Rica as part of a tropical ecology research project. While most of my current work uses a flow tube reactor, particle growth modeling, and aerosol measurement instrumentation (mobility analyzers, particle samplers, etc.), I also have experience using and a strong theoretical understanding of gas chromatography and both commercial and custom-built mass spectrometry. Additionally, I also work on projects that make use of Transmission Electron Microscopy and Raman Microscopy. I am looking for a career in the Northeastern or Mid-Atlantic region of the US that will allow me to approach problems hands-on and hone my skills as a scientist. A technical career working with scientific instrumentation would allow me to pursue my passion of science while also giving me the space to work creatively to tackle research questions.

4MJ.15

Yumeng Cui, Fifth-year Ph.D. Candidate, Research-related Job. YUMENG CUI, *University of California, Riverside*

My name is Yumeng Cui, a fifth-year Ph.D. candidate from the University of California, Riverside, and I anticipate my graduation in the Spring/Summer of 2023. My research projects focus on the formation of SOA particles and secondary brown carbon particles from anthropogenic and biogenic VOCs under various conditions, investigation of their chemical and optical properties, and determination of the compounds that contribute to the formation of chromophores in aerosol particles.

My first project (Cui et al., ACS Earth Space Chem., 2021) used chamber experiments to study the SOA formation from an anthropogenic (1-methylnaphthalene) and a biogenic (longifolene) VOC under different NO_x and NH_3 concentrations and relative humidity. My second project studies the SOA and brown carbon formed from single VOC vs. multi-VOCs systems by continuous-flow chamber experiments. Another ongoing collaborating project investigates the SOA formation from dimethyl sulfide in an oxidation flow reactor and the resulting particles' chemical composition. My final proposing project will use machine learning to study the experimental data collected from my past chamber experiments. The most important data from chamber experiments include the real-time mass spectra of the particles. However, the quantity and complexity of the mass spectrum data make it challenging to manually identify the important chemical ions related to the absorbing compounds in particles. Thus, in my last project, I plan to use machine learning to explore relationships between the SOA mass spectrum data and the simultaneously measured optical data in all the chamber systems I have studied.
After graduation, I would like to continue my track in scientific research-related careers. I am looking forward to the job opportunities related to atmospheric chemistry, air pollution, and climate change.

4MJ.16

Meet the Job Seekers-Ziying (Nancy) Lei. ZIYING LEI, *Texas A&M University*

My research interests include aerosol chemistry, aerosol physical properties (acidity, viscosity, morphology, and phase state), ice nucleation properties, and state-of-the-art instrumentation. My graduate work in the Prof. Andrew Ault group (University of Michigan, Ann Arbor) focused on understanding the role of acidity, viscosity, and morphology of atmospheric aerosol physicochemical properties and impacts. More specifically: 1) developing a novel single-particle acidity measurement using the degradation of a pH-sensitive polymer; 2) understanding the impacts of aerosol acidity on the formation and evolution of isoprene epoxydiol (IEPOX)-derived secondary organic aerosol (SOA) using an atomic force microscope with photothermal infrared spectroscopy (AFM-PTIR) and Raman microspectroscopy; 3) investigating the morphology and viscosity of submicron SOA from four different volatile organic compounds precursors (α-pinene, β-caryophyllene, isoprene, and toluene) reacted with IEPOX; 4) exploring a new glass transition temperature measurement to reveal the viscosity of individual submicron particles using AFM-PTIR with thermal analysis system. Those research projects have led to 18 publications, including 4 first-author papers.

As a Geoscience Future Faculty Postdoc Fellow at Texas A&M University Atmospheric Science Department, my research in the Prof. Sarah Brooks group expands on my understanding of aerosol acidity and morphology to further investigate the aerosol physicochemical properties that affect heterogeneous ice nucleation abilities: 1) investigate the effects of aerosol acidity and liquid-liquid phase separation on heterogeneous ice nucleation using Raman microspectroscopy with ice nucleation chamber; 2) explore the ice nucleation of size-depended submicron aerosol with varying pH using Continuous Flow Diffusion Chambers (CFDC).

With anticipated availability around fall 2023, I would ideally like to find a tenure-track faculty position to continue working in the field of atmospheric aerosols. I hope to continue growing as a diligent scientist within our aerosol research community. Ideally, I would like to relocate to the West Coast, but I'm open to any opportunities.

4MJ.17

Omar El Hajj, Ph.D. in Engineering, Research Scientist/R&D/Post-Doctoral Position. OMAR EL HAJJ, *University of Georgia*

My current research focuses on the physicochemical properties of combustion carbonaceous aerosols. In my research, I perform controlled combustion experiments to generate aerosols and measure their physical properties (size distribution and optical properties), in addition to collecting filter samples for offline chemical analysis using different mass spectrometry techniques (LDI, ESI-MS, nano-DESI-MS). My research led to the discovery of new aerosols that form under low temperature combustion (LTC) conditions with two-stage ignition fuels. The results were published in the journal Fuel.

Currently, we are exploring the effect of blending octane boosters on aerosol formation in LTC of two-stage ignition fuels, including biofuels additves. Part of my research also includes investigating the properties and cytoxicity of brown carbon (BrC) aerosols generated from biomass combustion, where I contributed in building a biomass gravimetric micro-feeder to perform controlled biomass combustion. Moreover, during November of last year I participated in a research campaign at the National Transportation Research Center (NTRC) at Oak Ridge national lab. The campaign’s objective was to study the effects of engine operation modes and fuels on the properties of the exhaust aerosols. I measured light absorption data of the aerosols emitted at each condition using a photoacoustic spectrometer and combined it with size distribution data to obtain optical properties.

Prior to my PhD research, I worked on sampling aerosols and gas phase emissions from electronic cigarettes (ECIGs). This was part of my masters thesis research and was funded by the FDA in order to regulate ECIGs in the US. I developed an experimental method that would predict operating conditions that release volatile carbonyl compound based on ECIG design features and user puffing behavior.

I am seeking a research scientist or postdoc position where I can utilize my technical skills in aerosol sampling, collection, analysis, and instrumentation in laboratory or field settings.

4MJ.18

Yucheng He, 4th Year Ph.D. Candidate, Air Quality Agency. YUCHENG HE, *University of California, Riverside*

I am a fourth-year Ph.D. student at the University of California, Riverside under the supervision of Professor Marko Princevac. My research topics although quite diverse, can all be encompassed in the field of fluid dynamics. My Ph.D. dissertation is focused on environmental phenomena such as air quality modeling and wildfire. Funded by TRDRP my research involved developing CFD simulations for the aerosol dispersion of E-Cigarette smoke in indoor environments. I have also worked on a clean cooking implementation project for rural Mexico funded by NIH: ISN; my contribution is to quantify the impact of stove emissions (PM2.5) on the outdoor neighborhood concentration using air quality models such as the CFD model Quick Urban & Industrial Complex model and the regulatory model AERMOD(EPA). I also developed a line source model based on Gaussian theory with the intention to generalize the results, improve computation efficiency and simplify the modeling process. Apart from the computational studies, in collaboration with USDA, Forest Service Pacific Southwest Research Station I designed and constructed an experimental setup specialized in quantifying ignition characteristics of wildfire fuels. Working with multiple collaborators throughout my research I was fortunate to enjoy as well as understand the intricacies of working with internationally located teams. Along with Ph.D. , I am currently pursuing a master’s degree in the department of computer science at Georgia Technology of Institution. The data processing and the visualization techniques obtained there helps me to enhance my ongoing environmental research. I learned using multiple programming languages such as MATLAB, Python, R, and SQL. Through this presentation, I want to explore career opportunities and communicate with specialists in the field.

4MJ.19

Emma Tackman, Graduate Research Assistant/PhD Sp 2023, Industry or Government Analytical/Environmental Chemist.

EMMA TACKMAN, *The Pennsylvania State University*

Currently at The Pennsylvania State University, University Park, PA 16802

My graduate work has focused on the synthesis and microscopic characterization of microdroplets and nanomaterials for use as proxies for atmospheric aerosol particles. Currently, I am developing a fluorescent probe for measuring the internal pH of aerosol particles. I am also studying the interactions between deposited aerosol particles and their substrates to better understand the differences between measurements of suspended and deposited particles. In the past, I have examined the phase transitions of mixed organic/inorganic model aerosol particles and the influence of increasing sucrose concentration.

My primary interests are environmental and analytical chemistry. I have experience in and I am passionate about both spectroscopy and microscopy. My undergraduate work at the University of Notre Dame involved the identification of falsified pharmaceuticals using surface-enhanced Raman, culminating in a first author publication. For my graduate studies at Penn State, I chose to pursue atmospheric chemistry with the hope that my work will fit into a larger context of climate change mitigation efforts. Here, I have chiefly used optical and electron microscopy for the examination of the physical and chemical characteristics of aerosol particles in an atmospheric context.

I am seeking a position in industry or government as an analytical and/or environmental chemist. I will be available for such a position starting mid Spring 2023 with location preferences in the North or Northeast regions of the US.

4MJ.20

Sanika Nishandar, 5th year Mechanical Engineering PhD Candidate, Aspiring R&D Scientist in Air Quality/Wildfires.

SANIKA NISHANDAR, *University of California, Riverside*

Sanika Nishandar is a final year PhD candidate under the guidance of Professor Marko Princevac at UC Riverside. Her doctoral work explores various environmental applications of fluid dynamics, specifically ignition and spread of wildfire, pollution monitoring in indoor and outdoor environments. Funded by TRDRP, her work focuses on dispersion of E-cigarette emissions in indoor environments. During pandemic this CFD study evolved into investigating the role of droplets and aerosols in the transmission of COVID-19. In a joint effort with UNAM, Mexico she studies the spread of cooking stove emissions (PM 2.5) in rural Mexican towns. This cyber-physical study deploys EPA regulated air quality models such as AERMOD in conjunction with water channel experiments. In collaboration with USDA, Forest Service (PSWRS) she designed and built an experimental setup to understand initiation and spread of wildfires. Experimental results of interaction between multifaceted fire structures are augmented by computational framework such as Fire Dynamics Simulator (NIST). An avid environmentalist and a strong advocate of science communication, she obtained a Graduate Certificate in Science to Policy and is currently a government relations committee member in the UCR student cabinet. Prior to her PhD she obtained MS degree in Mechanical Engineering wherein her thesis was on understanding the hemodynamics in cerebral aneurysms. This medical device intervention tested efficiency of placement of stents using Ansys FLUENT in an effort to reduce health risk of aneurysms. She plans to graduate by August 2023 and is inclined in working as an R&D scientist in the field of environmental studies which includes advancement in aerosol science. In the long run she envisions herself working towards bridging the gap between scientific research and the general audience. Through this poster presentation, she aims to promote her skillset to a wider audience and gain insight into a world beyond academia.

4MJ.21

Kanishk Gohil; Current: Ph.D. Candidate, University of Maryland; Desired: Postdoctoral Research Fellow. KANISHK GOHIL, *University of Maryland*

I am currently a fifth-year Ph.D. candidate at the University of Maryland, College Park. I work with Dr. Akua Asa-Awuku, and I study the effects of chemical composition and particle morphology on the CCN activity of ambient aerosols. My research can be broadly divided into 3 main projects: 1. Chemical classification of ambient aerosols using their Raman spectral signatures with the help of distance-based machine learning algorithms, 2. Development of a generalized hygroscopicity parameter for aerosol with varying physicochemical properties with the help of controlled droplet growth experiments, and 3. Incorporation of the newly devised hygroscopicity parameterization into the Single-Column Atmospheric Model (SCAM; National Center for Atmospheric Research) to analyze the variability in resulting cloud response. During my Ph.D. tenure, I have had the opportunities to do collaborative research at the Army Research Laboratory (ARL), and the University Corporation of Atmospheric Research (UCAR). As a Ph.D. student, I have gained significant hands-on experience in developing different machine learning classification algorithms, operating and analyzing laboratory data from the Continuous Flow Streamwise Thermal Gradient CCN Counter (CFSTGC), Aerodynamic Aerosol Classifier (AAC, Cambustion Ltd.), and Scanning Mobility Particle Sizer (SMPS, TSI Inc.), and operating the Community Earth System Model (CESM, NCAR) on High-Performance Computation systems.

I anticipate defending my dissertation in April 2023 and will be able to begin postdoctoral research anytime in the summer of 2023. I wish to primarily utilize my knowledge and further develop my experience in computational research, statistics, and machine learning. I would like to develop and improve my skills in surrogate modeling especially focusing on improving the prognostic and diagnostic capabilities of large-scale weather/climate models. I currently have no geographical preferences and am willing to work either in the US or internationally.

4MJ.22

Payton Beeler, Ph.D. Student (Washington University in St. Louis), Government/Academia. PAYTON BEELER, *Washington University in St. Louis*

As a scientist, I am interested in improving the understanding of small-scale aerosol processes on large-scale climate effects. My PhD research has focused on improving our understanding of shortwave absorption by internally mixed black carbon (BC). Specifically, I have quantified the effect of BC mixing state and morphology on its optical properties using discrete dipole approximation algorithms. Throughout my PhD research, I have gained skills in modeling stochastic systems such as diffusion limited aggregation and aerogel formation, single-particle optics, molecular dynamics, and density functional theory.

In the future, I hope to further expand my skills and expertise through postdoctoral training. I am interested in studying aerosol-cloud interactions, as they remain one of the largest sources of uncertainty in climate modeling. I hope to use my expertise in micro-scale modeling of aerosol processes to improve representation of aerosol-cloud feedbacks in global and regional scale models. I am also interested in using my previous research experience to improve the representation of aerosol optical properties in climate models. I am seeking postdoctoral positions at national laboratories and universities starting in the Fall of 2023. I do not have a strong preference for geographical location, and I am open to hybrid/remote arrangements.

4MJ.23

Sripriya Nannu Shankar, Graduate Research Assistant at University of Florida, Seeking a Postdoc or a Faculty Position in USA. SRIPRIYA NANNU SHANKAR, *University of Florida*

My PhD research is directed towards testing an aerosol exposure system mimicking the human respiratory system, for *in vitro* toxicological assessment of airborne particles. Briefly, I am (1) establishing a tool to predict delivered doses as an alternative to offline dosimetry methods; (2) developing a platform to represent global and local deposition as might occur in human lungs and (3) simulating wildfire burning in the laboratory to evaluate the impact of inhaling combustion byproducts, based on size-fractionation.

Recently, I secured an NIH TL1 predoctoral grant, through which I will be studying the impact of microplastic fibers on 3D cultured cells at the air-liquid interface, under *in vitro* conditions. Aside from inhalation toxicology, I have been contributing to different ongoing projects in our research group. When the pandemic started in 2020 (just when I started my PhD program), I initiated and led a student sampling team to assess the role of aerosols in transmission of SARS-CoV-2. Our efforts proved the role of aerosol transmission, and the knowledge contributed to revision of WHO/CDC guidelines and enforcement of mitigation strategies, to protect the public from exposure to the virus. Since then, I have been leading field sampling at different settings and training other students on conducting field studies. Furthermore, together with other engineers and public health experts, our group is developing a point-of-care tool to detect viruses in the air.

Aside from research, I am involved in several professional activities across the campus. I am the President of AAAR-student chapter at UF, campus ambassador for UF's Responsible Conduct of Research program, etc. With skills and knowledge in interdisciplinary research, I hope to accomplish my long-term goal of contributing to the knowledge gaps in bridging aerosol science, public health, and biology. As much as I enjoy research and expanding my knowledge, I love mentoring and look forward to training future engineers and contribute to their learning.

Anticipated availability: Fall 2023/Spring 2024

E-mail: snannushankar@ufl.edu

4MJ.24

PhD candidate Sabin Kasparoglu, NCSU. SABIN KASPAROGLU, *North Carolina State University*

I am looking for a postdoc or research scientist position with a career goal of continuous involvement in scholarly activities. I have an undergraduate background in Chemical Engineering and hold an M.S. degree in Atmospheric Sciences. I am currently a Ph.D. candidate in the Department of Marine, Earth, and Atmospheric Sciences at North Carolina State University. My research interests include atmospheric chemistry and physics to characterize the physicochemical properties of secondary organic aerosols. I have experience with instrument design and characterization, as well as laboratory and field research.

I have explored in-situ measurement of viscosity and ice nucleation ability for sub-200 nm size particles in colder temperatures, assembled and characterized an electrostatic precipitator, and characterized a modified optical particle spectrometer. I have experience using the following instruments: Differential Mobility Analyzers (DMA), Humidified Tandem Differential Mobility Analyzer (HTDMA), Scanning Mobility Particle Sizer (SMPS), Condensation Particle Counter (CPC), Printed Optical Particle Spectrometer (POPS), Unipolar Diffusion Aerosol Charger (UDAC), Electrospray Aerosol Generator, Single Soot Particle Spectrometer (SP2). Currently, I am involved with the DOE TRacking Aerosol Convection interactions ExpeRiment (TRACER-PFM) and stationed at the main site, where I am responsible for measurements of aerosol hygroscopic growth factors, black carbon, particle size distributions, and particle fluxes using the eddy-covariance technique.

I have teaching experience serving as TA for several courses in the Atmospheric Science undergraduate curriculum. I have also been nominated to be co-chair in the Instrumentation and Methods session of AAAR 2022. I published six peer-review journal articles being the first author in five of them. My next ideal job would be a postdoc or research scientist position in aerosol science, where I could further improve my research skills and learn new relevant topics to broaden my research horizon with the ultimate goal of securing a tenure-track faculty position in the US.

4MJ.25

Lucy Nandy, Postdoctoral Scholar, Seeking Tenure-Track Position in Chemical/Mechanical/Civil and Environmental Engineering/Chemistry. LUCY NANDY, *Pennsylvania State University*

My research projects so far have been a combination of aerosol thermodynamics, fluid mechanics, physical chemistry, and heat-mass transfer. Currently, I study ice nucleation in synthesized materials like zeolites and covalent organic frameworks (COFs) - immersion freezing and characterization studies. I am also involved in characterizing viscoelastic properties of model respiratory aerosol and investigating advection in the aerosol system. Earlier at University of Illinois, I studied water uptake and optical properties of mixed organic-inorganic atmospherically relevant particles.

At University of Minnesota during PhD, I advanced the perspective of aerosol multiphase phenomena, and their relevance to climate impacts. I used thermodynamic modeling and droplet microfluidic experiments for enhanced understanding of gas-to-particle partitioning, and liquid-liquid morphologies. My collaborative projects have aided me to discover applications in finding pH and hygroscopicity of particles and studying morphology of aerosol samples. I have former industrial experience working on 1) heat transfer model for cooling in steel slabs, 2) mixing model for homogenous alloy dissolution in liquid steel. During masters, I worked on development of microchannel assisted cooling devices involving image analyzing interferometry, and numerical simulation of evaporative processes using CFD.

My vision of developing a coherent research program merging all the skills gained from my research training will have enhanced understanding of water content in complex aqueous microenvironments such as atmospheric aerosols. My main objective as a faculty will be to mentor students in my group/class in development of reading, writing and research skills by actively engaging them. I will ensure equity and inclusion in my classrooms/research group by being approachable and respectful, and by displaying to the students that I care about their learning.

I will be available for a faculty position starting 2023, in Chemical/Mechanical/Civil and Environmental Engineering and Chemistry any location in United States.

5AC.1

Effects of Inorganic Salts and pH on the Gas-Aqueous Partitioning of Formic Acid. VIKRAM PRATAP, Rose Taylor, Joy Kiguru, Shawn Serafin, Alyssa Burns, Annmarie Carlton, Christopher Hennigan, *University of Maryland, Baltimore County*

Formic acid is one of the most abundant organic acids in the atmosphere. Formic acid is water-soluble and semi-volatile so it can partition to aqueous droplets and particles in the atmosphere. There is often a significant disparity between measurements and predictions of the abundance and gas-particle partitioning of formic acid. Inorganic salts in aqueous aerosols and cloud droplets may alter the partitioning of formic acid, potentially contributing uncertainty to these predictions. We conducted experiments using a dual mist-chamber setup to investigate the effects of salt identity, salt concentration, and pH on the partitioning of formic acid. We studied $(NH_4)_2SO_4$, $MgSO_4$, NaCl, $MgCl_2$, mixed salts ($(NH_4)_2SO_4$+ NaCl), and a sea water surrogate over the pH range 1 - 6. NaCl showed “salting-out” behavior at ionic strengths > 0.005 mol/kg and all pH values, while $(NH_4)_2SO_4$ exhibited “salting-in” at all pH and ionic strengths. In mixed salts, the additivity was found to be pH dependent: for pH > 2, sulfate salts appear to dominate while at pH < 2, chloride salts have a stronger effect. Monovalent and divalent cations also displayed non-uniform results that depend on the anion identity. For chloride salts, Mg^{2+} weakened the salting-out behavior in comparison to Na^+, but for sulfate salts, we did not observe any effect of Mg^{2+} on formic acid partitioning compared with NH_4^+. These observations demonstrate the importance of inorganic salts on the partitioning of organic compounds in the atmosphere, and also highlight the complexity of such organic-inorganic interactions.

5AC.2

Effects of RH and UV Light on the Formation, Composition, and Aging of SOA Derived from the High-NOx Oxidation of Ethylbenzene by Chlorine Radical. LEIF JAHN, Lea Hildebrandt Ruiz, *University of Texas at Austin*

Akylaromatic molecules are a class of volatile organic compounds (VOCs) that comprise a substantial source of secondary organic aerosol (SOA) precursors in urban and other polluted environments. Despite the importance of SOA derived from alkylaromatic VOCs, unknowns remain regarding how SOA forms and transforms in response to environmental factors such as relative humidity (RH) and ambient UV light. In the present work, we generate alkylaromatic SOA during laboratory chamber experiments and examine how SOA composition changes under different RH and lighting conditions. We choose to examine SOA formed during the reaction of ethylbenzene and chlorine radical under high-NOx conditions, typical of urban environments where alkylaromatic VOCs are common. The usage of chlorine radical enables the targeted study of alkylaromatic molecules and SOA formed when oxidation is initiated along the alkyl chain, a more minor pathway for OH chemistry compared to ring addition that becomes more prominent in larger alkylaromatic molecules. Gas-phase measurements using chemical ionization mass spectrometry (CIMS) show oxidation products consistent with initial oxidation along the ethyl chain followed by subsequent multigeneration reactions with OH radical formed through secondary chemistry. A Filter Inlet for Gases and Aerosols (FIGAERO) attachment for an I- CIMS and an aerosol chemical speciation monitor (ACSM) were used to analyze and compare aerosol composition across different RH and lighting conditions and over different timescales.

5AC.3

Comparisons of Physical Properties and Compositions of Irradiated Carbonyl-containing Aqueous Aerosols and Aerosol Mimic Solutions. JOSEPH WOO, Katherine Pierre-Louis, Bruno Loyola San Martin, Erin O'Leary, Daphna Fertil, *Lafayette College*

Carbonyl-containing volatile organic compounds (CVOCs) are ubiquitous in aqueous atmospheric aerosols, and have been identified as a source of a wide range of oligomeric products when aged under dark (nighttime) conditions. Recent studies exploring UV-irradiated (daytime) chemistry of dark-aged CVOC aqueous aerosol mimics have yielded further insight into their chemical fates, observing shifts in the extent of oligomerization in CVOC-derived heterocycles. The sustained gas-aerosol interface of droplets is hypothesized to enhance the formation of higher-mass and potentially surface-active products. This study explores the relative effect of surface/volume ratio on CVOC photochemistry by comparing the properties and extents of oligomerization of irradiated bulk, µL-scale hanging-droplet, and aerosolized CVOC/ammonium-sulfate solutions. ESI-MS, ex-situ surface tension, and UV/visible spectrophotometry measurements are reported.

5AC.4

Relative Humidity Effects on the Oxidative Aging of Isoprene Epoxydiol-Derived Secondary Organic Aerosol. ALISON FANKHAUSER, Madeline Cooke, Jin Yan, Cara Waters, Rebecca Parham, N. Cazimir Armstrong, Yao Xiao, Katherine Kolozsvari, Zhenfa Zhang, Avram Gold, Jason Surratt, Andrew Ault, *University of Michigan*

Organosulfates (OSs) formed from heterogeneous reactions of organic-derived oxidation products with sulfate ions are an important component of secondary organic aerosol (SOA) mass, primarily in submicron particles with long atmospheric lifetimes. Fundamental understanding of OS evolution in particles, including the formation of new compounds via oxidation, is limited, particularly across relative humidities above and below the deliquescence of typical sulfate aerosol particles. By generating aqueous particulate OSs and other SOA products from the acid-driven reactive uptake of isoprene epoxydiols (IEPOX) onto inorganic sulfate aerosols in a 2-m^3 indoor chamber at various relative humidities (30 – 80%) and injecting them into an oxidation flow reactor under the presence of hydroxyl radicals (·OH), we investigate the modification of particle size distributions, extent of inorganic sulfate conversion to organosulfates, and single-particle physicochemical properties. Chemical composition of particle-phase species, as well as aerosol morphological changes, are analyzed as a function of relative humidity and oxidant exposure times to better understand OS formation and destruction mechanisms in the ambient atmosphere.

5AC.5

Estimated Timescales for Wet Deposition of Organic Compounds as a Function of Henry's Law Constants.

CHENYANG BI, Gabriel Isaacman-VanWertz, *Virginia Tech*

Atmospheric organic compounds may deposit to Earth's surfaces via dry deposition, driven by gravity and/or concentration gradients, and wet deposition, driven by the washouts of compounds in rain or snow. Their removal by deposition has downstream impacts on concentrations of secondary organic aerosol (SOA) by preempting their atmospheric oxidation, which can form SOA. The impact of deposition processes can consequently be considered as competition between rates of oxidation and deposition, but timescales for deposition are not well constrained. While dry deposition timescale has been estimated and experimentally validated in the past, understanding of wet deposition is still very limited. In this work, we estimate the wet deposition timescale of gas-phase organic compounds in the atmosphere as a function of Henry's law constants, H_{eff}. Real-world precipitation frequency and size distributions at three sites provide a globally distributed estimate of this timescale. The wet deposition timescale decreased significantly with the increase of H_{eff} and became constant for compounds with H_{eff} $>10^5$ M/atm. We estimate that the median wet deposition timescale for compounds with H_{eff} $>10^5$ M/atm is approximately 5 hours during a continuous rain event for all three sites. However, median estimated timescales ranged from 80 to 200 hours, depending on location, and depend more on the frequency and duration of precipitation events rather than their intensity or size characteristics. We present to estimate timescales at any location for which basic precipitation information is available, use this approach to examine potential global distributions of timescales for wet deposition, and discuss them in the context of competition with other loss processes.

5AC.6

Secondary Organic Aerosol from Gas- and Aqueous-phase Oxidation of Volatile Organic Compounds in an Oxidation Flow Reactor.

NINGJIN XU, Chen Le, Kunpeng Chen, Ying-Hsuan Lin, David R. Cocker III, Don Collins, *University of California, Riverside*

A large fraction of organic aerosol (OA) in the atmosphere is secondary (SOA), produced either through the photooxidation of volatile organic compounds (VOCs) from biogenic and anthropogenic sources (gasSOA), or by irreversible aqueous phase reactions of organic compounds via cloud/fog droplets or wet aerosols (aqSOA). SOA formation through aqueous phase reactions could be significant, with several reaction pathways and products identified and studied. However, the production of aqSOA is hard to quantify and the importance of different mechanisms is still poorly understood, which is partly due to the lack of available measurement tools and techniques. Whereas quantification of the SOA yield resulting from gas phase oxidation of VOCs is fairly straightforward, determining the impact of further reaction of the products in liquid water is more challenging. Few studies have explored the contribution of different VOCs via aqueous phase chemistry relative to that via gas-phase pathways.

Here, we present experimental results of SOA formation through gas- and aqueous-phase oxidation of a variety of VOCs using a newly developed multiphase oxidation flow reactor, the Accelerated Production and Processing of Aerosols (APPA) reactor. Experiments were performed by oxidizing the VOCs in the presence of dry, aqueous, or activated seed particles inside the OFR, where the relative humidity (RH) was maintained between 40 and 100%. We report the SOA yield for gas- and gas+aqueous-phase oxidation as a function of OH exposure (OHexp). The properties of the aerosol-phase products were characterized by a high-resolution time-of-flight aerosol mass spectrometer (AMS) and a chemical ionization time-of-flight mass spectrometer (CIMS). We also report the SOA yield as a function of liquid water content, seed aerosol type, and dry seed aerosol surface area.

5AC.7

Regional Modeling of SOA Formation Considering Aqueous Chemistry under Different Humidities. YUJIN JO, Myoseon Jang, *University of Florida*

Secondary Organic Aerosol (SOA) contributes a significant fraction of particulate matter, and influences regional air quality and climate. SOA forms through complicated atmospheric oxidation paths of various Volatile Organic Compounds (VOCs). The spatial extent of SOA in the United State is different in the dry and humid regions, and also exhibits strong seasonality, connoting the contributors of SOA formation vary regionally and temporally. Since SOA formation is complex due to complexity in organic species and reaction mechanisms, it is challenging to accurately represent SOA in regional models. The prediction of SOA mass concentrations in regional scales is traditionally performed by using gas-particle partitioning models of few surrogate products. SOA growth via acid catalyzed heterogeneous reaction of isoprene products has recently been added to regional models. However, current air quality models have no feature to process aqueous reactions of a variety of oxidized organic products from different hydrocarbons. This limitation leads historically underestimated SOA mass concentration in the regional-scale air quality models as compared with observation, particularly in wet regions or humid seasons. In this study, the prediction of regional SOA mass concentrations is performed over the United State domain by using the Comprehensive Air quality Model with extensions (CAMx) coupled with newly developed UNIfied Partitioning-Aerosol phase Reaction (UNIPAR), which simulates the SOA formation via multiphase reactions of hydrocarbons. The CAMx-UNIPAR model includes multiphase partitioning and emerging chemistry (i.e., lowly volatile organic products via gas phase autoxidation, oligomerization of organic products in organic phase, aqueous reactions, and organosulfate formation). The SOA simulation of CAMx-UNIPAR is also compared to that predicted with the pre-existing SOAP model. The prediction of SOA mass concentrations with CAMx-UNIPAR is compared to observed field data. The CAMx-UNIPAR can improve the prediction of organic carbon concentrations in the presence of electrolytic inorganic aerosol for the humid regions.

5BC.1

Surface Films as a Mediator of Long-Term Air Quality and Health Impacts of Wildfire Smoke Events. SARAH STYLER, Iris Chan, Stephanie Schneider, Annie Cheng, *McMaster University*

Wildfire smoke is a major contributor to summertime air quality reductions in urban areas across the western United States and in Canada’s western provinces. Urban environments present many surfaces (e.g., buildings, roadways) to which pollutants can partition. Importantly, although the composition of urban surface films in a given area generally reflects that of co-located particulate matter (PM) samples, it also has a ‘memory effect’, in that transient alterations in PM composition result in long-term changes in film composition. In this context, we hypothesized that the composition of urban surface films in wildfire-influenced regions will reflect smoke influence, long after the smoke itself has dissipated, with attendant consequences for urban air quality and health. To explore this possibility, we deployed a network of low-cost surface film samplers in Summer 2022 in three types of environments: background, smoke-influenced, and smoke-dominated. Through intercomparison of site-specific film compositions, comparison of film data with compositional data from co-located PM stations (where available), and back-trajectory analysis, we provide comprehensive insight into wildfire smoke contamination of urban surfaces.

5BC.2

Wildfire as a Source of Environmentally Persistent Free Radicals and Reactive Oxygen Species. Ting Fang, Brian Hwang, SUKRITI KAPUR, Katherine Hopstock, Jinlai Wei, Sergey Nizkorodov, Manabu Shiraiwa, *University of California, Irvine*

Increase in wildfires in recent years due to climate change has put human population at growing risk as wildfire emits particulate matter (PM) that can cause reactive oxygen species (ROS) generation and oxidative stress. We collected size-segregated PM samples in California during two wildfire events and at highway and urban sites without wildfires. Environmentally persistent free radicals (EPFRs) are present predominantly on submicron particles (PM_1, aerodynamic diameter ≤ 1 µm) with a minor fraction in $PM_{1\text{-}10}$, likely semiquinone radicals absorbed on fine-mode soot particles or stabilized by coarse-mode tire/brake transition metals. In water, highway/urban PM form mainly hydroxyl (OH·, 84-88%) and carbon-centered (R·, 12-16%) radicals, whereas R· accounts for a major fraction (~50%) with contributions from superoxide/ hydroperoxyl ($\cdot O_2^-$/$\cdot HO_2$) and oxygen-centered (OR·) radicals in wildfire PM. Total dithiothreitol activities (OP-DTT) were found to be high in wildfire PM_1, consistent with submicron organics emission from biomass burning. Interestingly, OP-DTT of highway/urban samples are correlated with ROS generation (Hwang et al., ACSESC 2021), while no correlation is observed in wildfire samples, suggesting that OP-DTT might not be a good metric for ROS generation and toxicity in biomass burning aerosols. Combustion condition plays an important role that flaming generates more radicals and higher OP-DTT than smoldering or pyrolysis.

5BC.3

Photolytic Mass Loss of Secondary Organic Aerosol (SOA) Derived from Biomass Burning Precursors in Different Relative Humidity. NARA SHIN, Yuchen Wang, Taekyu Joo, Pengfei Liu, Nga Lee Ng, *Georgia Institute of Technology*

Biomass burning (BB) is one of the major sources of organic aerosol (OA) and volatile organic compounds (VOCs) in the atmosphere. The atmospheric oxidation of the emitted BB VOCs can lead to the formation of secondary organic aerosol (SOA). The SOA formed in the atmosphere undergoes multiple loss processes, such as photochemical processes (including photolysis and photooxidation), hydrolysis, and wet and dry deposition. However, the photolysis behaviors of biomass burning SOA (BBSOA) and their impact on aerosol lifetime have not been well constrained. Previous studies have shown that furan species are important sources contributing to BBSOA formation. In this work, we investigated the effect of photolysis on BBSOA formed by photooxidation of furan compounds (2-methylfuran, 3-methylfuran, and furfural) at high NOx conditions. BBSOA was produced in chamber experiments under dry (<5%) and humid (~50%) conditions. The formed BBSOA was deposited onto a quartz crystal substrate and the mass-loss rates of SOA under specific UV lights (300 and 340 nm) were measured using a Quartz Crystal Microbalance (QCM). The results indicate 15-35% and 3-10% mass losses under UV illumination of 300 and 340 nm, respectively. The BBSOA produced from 2-methylfuran and 3-methylfuran at dry condition (< 5%) has relatively a higher mass-loss rate from both 300 and 340 nm lights compared to those formed at humid condition (~50%). On the other hand, furfural BBSOA formed under dry and humid conditions shows a similar mass-loss rate (33%). The observed photolytic mass losses are linked to the chemical composition of BBSOA formed under different RH conditions, as a result of differing gas- and particle-phase chemistry. Overall, this study highlights changes in the lifetime of BBSOA induced by photolysis, which indicates that photolysis can be a potential fate and loss mechanism of BBSOA in the ambient environment.

5BC.4

Understanding the Contributions of Medium- and Long-range Atmospheric Transport of Biomass Burning to Organic Aerosols in Bogotá, Colombia. RICARDO MORALES BETANCOURT, Fernando Garcia-Menendez, Karen Ballesteros, Amy P. Sullivan, *Universidad de los Andes*

Recent field campaigns and modeling studies in Colombia have demonstrated the presence of a large Organic Aerosol (OA) fraction in urban and rural aerosols, a portion of which is due to transport of regional Biomass Burning plumes. In this work we focus on understanding the sources associated with OA and its precursors over the city of Bogotá, Colombia. We used WRF-Chem chemical transport model to investigate the contributions from medium- and long-range transport of biomass burning plumes towards the city of Bogota. To that end, we carried out regional-scale simulations with two different chemical mechanisms and aerosol schemes, RACM/MADE-VBS and MOZART/MOSAIC. Sensitivity simulations were also carried out were the influx of BB plumes at the outermost domain boundary were removed. Modeling results were compared to detailed in-situ aerosol chemical speciation data and continuous Brown Carbon and Black Carbon observations. Simulations were set-up for periods of high biomass burning (BB) activity (January-March) and a low BB activity (July-September) during 2018. We demonstrate that long-range transport of BB emissions from Northern Amazonia can episodically increase aerosol loading during September, while BB activity in the Grasslands of the Orinoco River Basin are the main source during January to March. The two aerosol schemes utilized in this work reproduce the observed seasonal variations in total fine aerosol concentration, with a difference between high- and low- BB sesasons of 10 $\mu g/m^3$. The comparison between aerosol schemes showed that MOZART/MOSAIC consistently predicts more OA with a larger SOA:OA ratio than in the RACM/MADE-VBS experiment. SOA dominates the OA fraction by 66% for RACM/MADE-VBS and 74% for MOZART/MOSAIC during February and 69% for RACM/MADE-VBS and 71% for MOZART/MOSAIC during September. These differences between organic aerosol burden between the mechanisms used in this study may be attributed to the different treatment of SOA gas/particle partitioning in the schemes. During both periods, the simulation in which boundary influx was removed showed nearly 1.2 $\mu g/m^3$ lower SOA, suggesting that precursors from long-range transport can substantially impact OA concentrations in the city.

5BC.5

Multi-modal Mass Spectrometry Studies of Atmospheric Aerosol Aging. KYLA SIEMENS, Demetrios Pagonis, Hongyu Guo, Pedro Campuzano-Jost, Jose-Luis Jimenez, Alexander Laskin, *Purdue University*

This work demonstrates an application of multi-modal mass spectrometry techniques to reveal aging characteristics of individual molecular components of organic aerosol (OA), to determine their fate in the atmosphere. We present the molecular characterization of biomass burning OA sampled from the Williams Flats regional wildfire in Washington state on August 3rd 2019. OA was analyzed in-situ using a high-resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS) and an extractive electrospray ionization time-of-flight mass spectrometer (EESI-MS) deployed onboard the NASA DC-8 research aircraft. Complementary bulk samples of OA were collected for offline laboratory analysis using high performance liquid chromatography interfaced with photodiode array and electrospray ionization high resolution mass spectrometry (HPLC-PDA-ESI-HRMS). HR-ToF-AMS measurements revealed unusually abundant organic-sulfur (OS) species as notable components of OA. Analysis by HPLC-PDA-ESI-HRMS identified molecular characteristics of these unusual organic-sulfur species. Accurate HRMS measurements and MS^n fragmentation experiments identified that alkyl benzene sulfonates (ABS) dominated those unusual OS compounds. Organic sulfate, nitroaromatic, and oxygenated aromatic species were also identified. Guided by the HRMS results, time-resolved aging profiles of ABS and selected individual OA species were retrieved from EESI-MS data to evaluate their fate in the emission plume. In-plume OA concentrations were corrected with carbon monoxide concentrations to account for plume dilution and were examined with respect to smoke age to assess their evolution in the atmosphere. The ABS remained stable within the observed aging time, the half-life time of decaying organic-sulfate species was as short as 1.3 hours. The nitroaromatic and oxygenated aromatic species exhibited decay with average half-lives of 1.8 and 2.2 hours, respectively.

5BC.6

Multi-Day Evolution of Organic Aerosol Mass and Composition from Biomass Burning Emissions. ABRAHAM DEARDEN, Ali Akherati, Charles He, Christopher Lim, David Hagan, Christopher Cappa, Jesse Kroll, Jeffrey R. Pierce, Shantanu Jathar, *Colorado State University*

Biomass burning is an extremely important source of primary organic aerosol (POA) and volatile organic compounds (VOCs) to the atmosphere. Yet there are large uncertainties surrounding the oxidation chemistry of POA and VOCs leading to SOA formation, especially over long photochemical ages. Recently, Lim et al. (ACP, 2019) performed photooxidation experiments on biomass burning emissions using a small environmental chamber (~150 L) at the Fire Sciences Laboratory in Missoula MT. A total of 20 experiments were performed on emissions from ~15 different fuels found in the western United States. In this work, we use a state-of-the-science model, SOM-TOMAS (Statistical Oxidation Model-TwO Moment Aerosol Sectional), to simulate the physicochemical evolution of organic aerosol (OA) in these chamber experiments. Here, SOM-TOMAS simulates the oxidation chemistry, thermodynamic properties, and microphysics of OA, in addition to accounting for rapid dilution and wall losses. The model was able to simulate the time-dependent evolution of the OA mass concentration and its oxygen-to-carbon ratio when initially applied to several select fires. These preliminary results also indicated that the same VOC classes that have previously been found to be important for SOA formation in smoke (oxygenated aromatic, heterocyclic, and semi-volatile compounds) at shorter photochemical ages (<12 hours) are also relevant at longer photochemical ages (~1 day to ~1 week). However, the relative contribution of the different VOC classes to the total SOA formation varied significantly with time. Ongoing work is focused on model application to the complete dataset as well as an investigation of the complex role of semi-volatile organic compounds and heterogeneous chemistry on the evolution of OA mass and composition.

5BC.7

Diffusion Coefficients and Phase Behavior of Biomass Burning Organic Aerosol. F. K. A. GREGSON, N. G. A. Gerrebos, C. E. Schwartz, S. Kamal, C. Carlsten, A. K. Bertram, *University of British Columbia*

Emissions produced through biomass burning are among the largest contributors to worldwide organic aerosol, thereby significantly impacting human health and the climate. An improved understanding on the phase behaviour and diffusion coefficients within biomass burning organic aerosol (BBOA) is needed to understand this impact. Diffusion coefficients can affect the growth rates and size distributions of atmospheric aerosol as well as controlling heterogeneous reaction rates and the rate of whitening of the brown carbon in BBOA. The phase behaviour, i.e. how many phases are present in the particles and their morphology, is important for the equilibrium partitioning of semi-volatile organic compounds (SVOCs), heterogeneous reaction rates and whitening rates, as well as influencing the ability of BBOA to activate into cloud droplets.

BBOA emissions can be compositionally complex due to evolution in the atmosphere including through dilution, oxidation and partitioning of SVOCs. As a bottom-up approach towards understanding the properties of particles present in forest fire plumes, we study lab-generated proxies of primary emitted BBOA. In a controlled furnace tube, wood smoke particles are generated from heating wood under smoldering conditions at varying heating temperatures. We observe the phase behaviour of the sampled BBOA by exposing the particles to varying relative humidity (RH) within a flow cell coupled to an optical microscope. We also measure the diffusion coefficients of organic molecules in the collected woodsmoke particles using fluorescence recovery after photobleaching (FRAP). We show that the phase behaviour of primary emitted woodsmoke aerosol varies with RH, with some particles undergoing liquid-liquid phase separation at a separation RH (SRH). We report the diffusion coefficients of the single phase below the SRH, or of the two separate phases above the SRH. These results have important implications for understanding the affects of woodsmoke particles on air quality, the climate and human health.

5HA.1

The Effects of Photochemical Aging of Combustion Particles with Secondary Organic Aerosol Interactions on Cellular Toxicity.

REUBEN ATTAH, Kamaljeet Kaur, Kerry Kelly, *University of Utah*

Fine particulate matter (PM 2.5) is associated with numerous adverse health effects, such as pulmonary and cardiovascular diseases and premature death. Primary organic combustion particles and secondary organic aerosol (SOA) derived from the oxidation of anthropogenic VOCs are significant components of ambient particulate matter. Atmospheric aging induces changes in their chemical composition. However, the impact of these changes on human health is poorly understood. This study aims to understand how the atmospheric aging of primary combustion particles and its interaction with secondary organic aerosols affects biological responses. Combustion particles were produced by combusting a jet-fuel surrogate in the flat-flame burner and photochemically oxidized in a potential aerosol mass (PAM) oxidation flow reactor. SOA was produced by the oxidation of toluene vapor in the PAM reactor. The PAM simulated atmospheric aging of 10 days by exposing the combustion particles and combustion particles coated with SOA to OH radicals in the presence of 245nm ultraviolet light, humidity, and ozone. The O_3/OH and HO_2/OH ratios in the PAM reactor were similar to atmospheric values. The particle size distribution, molecular structure, and composition of soot and SOA particles were characterized by SMPS, FTIR, and GCMS, respectively. Monocultures of human epithelial cells A549 and co-cultures of A549 and THP-1 macrophages grown under submerged conditions were exposed to the three particle types at concentrations of 25μg/cm^2 6μg/cm^2 and 1.5μg/cm^2. After an 8-hour exposure, cytotoxicity, xenobiotic metabolism (CYP 1A1), and pro-inflammatory biomarkers, IL-8 and TNF-α, were evaluated. The monoculture of A549 cells demonstrated a higher IL-8 response to aged combustion particles than to fresh combustion particles suggesting that oxidized species at the particle surface strongly contribute to PM2.5 inflammatory response.

5HA.2

Estimation of Respiratory Deposited Doses for Metals in Submicron Aerosol Using Mobile Aerosol Lung Deposition Apparatus (MALDA).

JINHO LEE, Inkyu Han, Masoud Afshar, Wei-Chung Su, *University of Texas Health Science Center at Houston*

Submicron aerosol inevitably could be inhaled in human respiratory and the consequent deposition of submicron aerosol in the human's lower airways could lead to adverse health effects. Hence, the exposure to submicron aerosol has been and continues to be an essential occupational and environmental health issue. To correctly estimate health risks caused by the exposure to submicron aerosol in the workplace and the environment, it is important to acquire aerosol respiratory deposition data and aerosol chemical composition in various environments. This study used a special approach that combines several aerosol characterization methods to estimate the respiratory deposited dose of selected metals contained in the submicron aerosol.

The aerosol particle size distribution was measured by NanoScan SMPS, the aerosol samples were collected by MOUDI, and the aerosol size-dependent metal composition was analyzed by ICP/MS. The critical aerosol respiratory deposition data were acquired by a newly developed human lung respiratory tract model, Mobile Aerosol Lung Deposition Apparatus (MALDA). The MALDA has 3D-printed human respiratory tracts (Head airway, Tracheobronchial airway, and Alveolar region) and can measure the deposition fraction of ultrafine particles in the human lung in a short time.

Based on the 1) size-dependent metal composition of particulate matter in the ambient air obtained from MOUDI and 2) size-dependent aerosol respiratory deposition fraction in head to TB airway and alveoli region obtained from MALDA, the respiratory deposited dose of aerosol was estimated. The experiment was carried out at an outdoor industrial section in Houston, Texas.

Results obtained showed that the hourly respiratory deposited dose of harmful metals contained in ambient submicron aerosol could be ideally estimated in the human head-to-TB airways and alveolar region. Over the half of the ultrafine particles of seven target metals (Cr, Ni, V, Mn, Cu, Pb, and Fe) were deposited in the alveolar region of MALDA (from 52.3% to 53.1%), and the hourly deposited dose was varied from 474.5 to 41,409.0 ng/hr. The deposited dose of metal was highest at the aerosol diameter of around 100 nm.

The deposited dose acquired in this study can be used to calculate the cumulative deposited dose due to prolonged aerosol exposure and then be further applied to estimate the associated health risks.

5HA.3

Examining the Oxidation State of the Metals in the Aerosols and Vape Liquid of Electronic Cigarettes. KAPIAMBA KASHALA FABRICE, Stephen Adom, Yue-Wern Huang, Yang Wang, *Missouri University of Science and Technology*

Since their invention, electronic cigarettes (ECs) have been promoted as safer alternative means of quitting smoking and avoiding inhaling toxic substances. However, several studies have confirmed the presence and, in some instances, high levels of similar toxic substances found in EC aerosols. Specifically, though several toxic substances have been associated with ECs usage, heavy metal poisoning is of concern due to their potent toxicity at low concentrations, even at nanograms scale per puff (Kapiamba et al., 2022). Nevertheless, knowing that some metals in certain oxidation states are known to be safe depending on the exposure route, there is a need to study the oxidation states of these metals.

In this study, using X-ray photoelectron spectroscopy (XPS), we examined the oxidation state of metals collected in the aerosols generated from ECs and contained in the vape liquid. The XPS survey spectrum of filters film the presence of metals previously characterized using ICP-MS, namely Cr, Cu, Ni, Pb, and Zn. The corresponding high-resolution spectra of Cr 4f, Cr 3d, Cu 2p, Ni 2p, Pb 4f, and 5d, Zn 2p were studied and revealed metal oxidation states. For instance, Zn 2p showed two spin-orbit components, $2p_{3/2}$ and $2p_{5/2}$; the 3d and 4f of Cr were also observed, referring to the least toxic Cr(III) species, unlike the carcinogenic Cr(VI). Furthermore, increased ECs power settings changed proportions between peaks of different binding energies, while nicotine concentration in vape liquids did not affect metal oxidation states. Moreover, metal oxidation states do not vary while transferred from the liquids to the aerosols. This study provides information regarding the potential toxicological effects of metals emitted from ECs.

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5HA.4

Predict Transport and Deposition of Multicomponent E-cigarette Aerosols in a Subject-specific Airway Model with Different Nicotine Forms: An in silico Study. Ted Sperry, Jianan Zhao, YU FENG, Chen Song, Zhiqiang Shi, *Oklahoma State University*

Predicting the transport and deposition of e-cigarette aerosols in the human respiratory system is essential to understanding how initial e-liquid compositions, especially different nicotine forms in new generations of e-cigarette products, can influence the absorption of nicotine in the human lung. Using a newly developed computational fluid dynamics (CFD) based numerical method which integrated the species transport and discrete phase (DPM) models, this study simulated and compared the transport dynamics of multicomponent e-cigarette aerosols in a subject-specific human respiratory system, and investigated how nicotine forms, nicotine mass fraction, PG/VG ratio, and acid/nicotine ratio in the e-liquids can influence the transport, evaporation/condensation dynamics, and deposition/absorption patterns in the human airway from mouth to generation 6 (G6). Specifically, the experimentally calibrated and validated CFPD model is able to predict the gas-liquid phase change dynamics of water, PG, VG, and nicotine in the aerosols during their transport through the pulmonary route. Freebase nicotine and nicotine salt were both investigated, with different PG/VG ratios and benzoic or lactic acids. Simulation results indicate that compared with free-based nicotine e-liquid, using nicotine salt with Benzoic and Lactate Acids will reduce the headspace nicotine saturation pressure, thereby reducing the evaporation rate of nicotine, which leads to lower nicotine absorption in the human upper airway and higher nicotine absorption in small airways. In addition, increasing PG/VG ratio will also reduce the headspace nicotine saturation pressure, further reducing the evaporation rate of nicotine. In summary, a CFD-based species transport-DPM model has been developed and validated to quantify how e-liquid composition can influence the transport, evaporation/condensation, and deposition/absorption of inhaled multicomponent e-cigarette aerosol in human respiratory systems. Future work will include (1) investigating how disease-specific lung airway deformation kinematics can influence the inhaled nicotine distributions, and (2) quantifying the pharmacokinetics of nicotine after deposition/absorption in the human body.

5HA.5

An Artificial Lung Model for Characterizing Deposition of E-cigarette Aerosols in Human Tracheobronchial Airways.

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

Knowing the characteristics and deposition of inhaled e-cigarette (e-cig) aerosols within the human lung is key for understanding delivery, exposures, and potential toxicity. Current knowledge is limited and often derived from studies that ignore the dynamic aspects of the lung environment. To better understand the physiochemical characteristics and lung deposition of e-cig aerosols, we developed an artificial lung model that consists of a 6L lung exposure chamber. It can be fitted with a trachea alone or with modeled airways down to the 13th generation. The model is attached to a ventilator so that it breathes continuously and can be exposed to intermittent vapes of e-cig aerosol. A heating and humidification system can be independently controlled to approximate the human lung environment.

We studied the size-resolved deposition fraction of e-cig aerosols on the tracheobronchial airways by measuring the size distribution of e-cig aerosols in the lung model with and without the tracheobronchial airways. Our results show a bimodal number-based size distribution of e-cig particles in the lung model. An average of 14% of particles between 40 and 80 nm failed to pass through the terminal bronchial orifices, consistent with airway deposition. Ongoing studies will compare the measured aerosol distribution with those predicted by a computational fluid-particle dynamics model. In addition, we will characterize the e-cig aerosols exhaled by the artificial lung model.

This study provides novel insight as to the physicochemical characteristics of e-cig aerosols inhaled in the lung and valuable information for the exposure analysis of active and passive vaping.

5HA.6

The Lobar Deposition of Little Cigar Smoke Particles in Sprague-Dawley Rat Lungs.

KAISEN LIN, Christopher Wallis, Emily Wong, Patricia Edwards, Laura Van Winkle, Anthony S. Wexler, *University of California, Davis*

Quantifying the dose of tobacco smoke and the location of this dose in the respiratory system is important in understanding its toxicity, addiction, and health effects. Human epidemiology studies have reported that lung tumor incidences varied in different lung regions, i.e., there are more lung tumors in the distal airway than central airway. One hypothesis is that smoke particles deposit heterogeneously in lung airways, which leads to more adverse health effects in certain lung regions. However, not many studies have investigated the pulmonary spatial distribution of inhaled particles from tobacco smoke. Even fewer have explored the particle size distribution of smoke from little cigars, the total dose, and the lobar deposition of particles. Given the increasing popularity of little cigars, especially in young populations, there is an urgent need to conduct research and collect data on this topic. In our study, we explored the lobar deposition of particles from combusted Swisher Sweets regular and menthol-flavored little cigars in rat lungs. We exposed 12-week old male and female Sprague-Dawley to particles at a mass concentration of 80 mg/m3 for 2 hours. Rats were sacrificed immediately after the exposure and lungs were separated to collect individual lobes. The lobe-by-lobe deposition of little cigar smoke particles was calculated based on the deposition of trace metals, which serve as markers of smoke particles and were quantified with inductively coupled plasma mass spectrometry. Trace metal levels were also determined on Day 0, 1, 7, and 28 post-exposure to investigate particle clearance and help understand the long-term health effect of little cigar smoking.

5HA.7

Detecting Lung Disease with Aerosolized Nanoparticles. MADELEINE PETERSSON SJÖGREN, Jonas Jakobsson, H. Laura Aaltonen, Amelia Grosso, Davide Piloni, Frederica Albicini, Erica Gini, Angelo G. Corsico, Per Wollmer, Jakob Löndahl, *Lund University, Sweden*

Methods sensitive to detect changes in the peripheral lung, including enlarged airspace size due to emphysema, a major component of chronic obstructive pulmonary disease (COPD), are lacking. Moreover, the global prevalence of COPD is increasing, and the disease is underdiagnosed. We hypothesize that we can derive peripheral lung airspace size from measurement of lung nanoparticle deposition. The method is called Airspace Dimension Assessment (AiDA) and the aim of this study was to compare AiDA measurements in subjects with and without COPD.

This study was a collaboration between the aerosol group at Lund University in Sweden and the Department of internal medicine and medical therapeutics at the University of Pavia in Italy. The study population was recruited in Sweden and Italy, including 34 subjects with COPD from tobacco smoking and 28 subjects with COPD due to Alpha-1-Antitrypsin deficiency (AATD). AATD is a genetic disorder that significantly increases the risk for developing emphysema, while COPD due to tobacco smoking cause both bronchial disease and emphysema. Data on healthy subjects were available from a national population-based Swedish cohort. Lung function was assessed with spirometry, diffusion capacity for carbon monoxide and AiDA. Computed tomography chest scans were made for all COPD subjects.

Average airspace sizes measured with AiDA were elevated for subjects with COPD, both from tobacco smoking ($P<0.0001$) and AATD ($P<0.0001$), but airspace size varied substantially between individuals. Mean airspace size was 375 ± 114 µm for subjects with COPD due to smoking, 322 ± 68 µm in subjects with AATD and COPD, and 280 ± 34 µm for healthy subjects. AiDA could differentiate between the AATD group and the healthy subjects, in contrast with other standard pulmonary function tests. These data support the hypothesis that AiDA measures distal airspaces and show that AiDA has the potential to increase phenotyping of lung disease.

5IM.1

Quantifying Residence Times in Neutralizers to Improve Temporal Resolution of Measurements. ROBERT T. NISHIDA, Mino Woo, Tyler J. Johnson, Jason S. Olfert, *University of Alberta*

Many aerosol instruments utilize bipolar charge conditioners (neutralizers), including the widely-used scanning mobility particle sizer (SMPS). To capture transient changes in aerosol size and concentration, new ‘fast scanning’ techniques (e.g. <15 s scans) have been developed creating new demands for temporal response of the system, including the neutralizer. In this work, we quantify residence times of particles in a common Kr-85 neutralizer (TSI 3077A; TSI Inc.) at two flow rates (0.3 and 1.5 L/min), with and without a flow insert recommended by the manufacturer. We find that at 1.5 L/min nearly all particles pass through the neutralizer in <10 s. At 0.3 L/min, most particles (>80%) pass through the neutralizer in <10 s, however, the remaining particles take significantly longer (>100 s). The wide distribution of residence times indicates significant jetting and recirculation of flow within the neutralizer. The large disparity in residence times would significantly affect ‘fast scanning’ when attempting to capture transients in the aerosol. The relatively long (>100 s) delay for some particles means the temporal resolution of the SMPS is limited by the flow field in the neutralizer rather than the voltage scan time. Thus, better SMPS temporal resolution can be obtained with better neutralizer design. Furthermore, particle charge may be affected since particles would have drastically different exposure time to ions even in the same neutralizer. We perform detailed computational fluid dynamics (CFD) modelling of the neutralizer and quantify residence time distributions numerically. The simulation results agree well with the experimental data and confirm jetting and recirculation of flow in a sudden expansion (a common fluid dynamics problem). Finally, we present a new neutralizer design, optimized using CFD, which minimizes recirculation and achieves the desired charge levels, and we experimentally demonstrate its suitability for measurements with high temporal resolution.

5IM.2

Measuring Size Distributions of Atmospheric Aerosols Using Natural Air Ions. YIRAN LI, Xiaotong Chen, Jingkun Jiang, *Tsinghua University, China*

Electrical mobility size spectrometers are widely used to measure ambient aerosol number size distributions. A key component of these mobility systems is the charge conditioner, or neutralizer, which is used to place a stationary charge distribution on the aerosols prior to mobility analysis. Yet, there are natural air ions in the atmosphere which are constantly conditioning the charge state of atmospheric aerosols. In this study, we demonstrate that this natural charging process can be utilized by these spectrometers to measure size distributions of atmospheric aerosols without using a conventional neutralizer. This is achieved by measuring charged particles of both polarities, in contrast to only one polarity as conventionally done. The bipolar data is used to retrieve air ion properties from which the aerosol charge fractions are calculated. We deployed this new method in urban Beijing to measure atmospheric aerosols over a period of two years and verified that size distributions can be effectively measured using natural air ions. There is good agreement in aerosol size distributions when comparing this new method to a conventional spectrometer, and good agreement in total particle number concentrations measured by a condensation particle counter. Additionally, measuring charged particles of both polarities makes the uncertainties due to aerosol charging now traceable. We show that during two years of measurement in urban Beijing, the properties of ions produced by conventional neutralizers drifted due to the aging of ion sources, while the properties of natural atmospheric ions remained stable over time, despite occasional short-period fluctuations.

5IM.3

Effects of Gas-Phase Components on Measurement of Secondary Organic Aerosol Size Distribution. YUANLONG HUANG, John Seinfeld, Richard Flagan, *California Institute of Technology*

The measurement of airborne particle size can be divided into three steps: charging the particles, separating charged particles in an electrical field, and counting the separated particles, typically with a condensation particle counter. Each step should be well understood to carry out a precise size inversion. Here we focus on the charging process in a soft X-ray ambipolar diffusion charge conditioner to establish a fundamental understanding of ion generation and the interaction between particles and the ions used to charge them. The particle charge state depends on the residence time distribution inside the charge conditioner, the gas composition, and the ion concentrations and properties. It is typically parameterized for steady-state operation in dry ambient air. However, a non-equilibrium or biased charge state can exist due to the presence of unanticipated gas-phase species, particle shape, or downstream wall losses of ions of different mobilities, or electric fields due to charge build-up on insulating surfaces within the charge conditioner. We have developed a dual-polarity differential mobility analyzer that measures both positively and negatively charged particles. Using this instrument, we measure the particle charge distribution resulting from a custom soft X-ray charge conditioner in the presence of various gas-phase species in typical chamber and flow tube experiments. We investigate the effect of the presence of the most common oxidants that are usually present in excess during chamber experiments (e.g., O_3 and H_2O_2) and the humidity on the ion generation and the particle charge distribution in a soft X-ray diffusion charge conditioner. These effects must be considered when deriving the SOA yields from the experimental data.

5IM.4

Performance Comparison of TSI's New Wide-Range and Established Long Differential Mobility Analyzer. Justin S. Koczak, ANDREA J. TIWARI, Torsten Tritscher, Sebastian H. Schmitt, Timothy Wright, Markus Petters, *TSI Incorporated*

The TSI Long Differential Mobility Analyzer (Long DMA, Model 3081/3081A) has become an established reference instrument in aerosol sizing (Kinney et al 1991). They have been in use for more than 40 years and have been employed in a variety of applications, including atmospheric chemistry (Cocker et al 2001) and ambient aerosol monitoring (Birmili et al 2016).

The TSI Long DMA is considered a general-purpose DMA for many different applications. Some ambient air quality researchers, particularly in the European community, however, have instead used the DMA design originally developed by the University of Vienna (Winklmayer et al 1991). Notably, TROPOS in Leipzig introduced a DMA based on the Vienna design. The “TROPOS DMA” has since become established in the ambient monitoring literature, and is a now a widely-respected instrument within the European ambient monitoring community (e.g. ACTRIS and GUAN). In response to growing interest in ambient monitoring research, TSI has recently introduced the Wide-Range DMA (W-DMA, Model 3083), which is based on the TROPOS design, to expand the applications of the Scanning Mobility Particle Sizer™ Spectrometer (SMPS, Model 3938).

The Long DMA and the TROPOS-designed DMA have an overlapping size range. While transfer function statistics for the TROPOS DMA and Long DMA have been investigated in prior work (Birmili et al 1997), an in-depth performance comparison between the new W-DMA and the Long DMA has not yet been presented.

This work examines the size accuracy of the W-DMA for monodisperse particles, comparing theoretical computations to experimental work. Modeling of DMA transfer was performed using an open-source model (Petters 2021). The model predicts the output of a hypothetical tandem DMA setup, where DMA 1 selects quasi-monodisperse particles and DMA 2 scans over a range of mobility. The model assumes the diffusion-broadened theoretical DMA transfer function computed based on the dimension and flow rates in each DMA. The normalized concentration corresponds to the ratio of particle concentration measured by a condensation particle counter after DMA 2 divided by the particle concentration after DMA 1. Example model calculations for a sheath flow rate of 5 L min-1 and over a range of particle sizes show that for particles 50 nm and larger, the transfer functions are nearly identical between the two DMA models. We anticipate presenting observational data that shows the degree to which either DMA model conform to this theoretical expectation.

5IM.5

Comparison of 100 nm Monodisperse Particle Size Measured by Four Accurate Methods. Kaleb Duelge, GEORGE MULHOLLAND, Vince Hackley, Natalia Farkas, John Kramar, Michael Zachariah, Keiji Takahata, Hiromu Sakurai, Kensei Ehara, *National Institute of Standards and Technology*

Measurement results for the number mean diameter of 100 nm monodisperse polystyrene spheres (JSR SC-010-S, SRM1963) by four independent methods will be presented. These methods are differential mobility analysis (DMA), atomic force microscopy (AFM), scanning electron microscopy (SEM), and electro-gravitational aerosol balance (EAB). The first three of the methods are traceable to the wavelength of light with the two microscopies traceable via NIST’s Calibrated Atomic Force Microscope. The fourth method, with the lowest uncertainty of the four measurements, is based on a direct relationship between the particle diameter and the voltage, electrode spacing, particle density, and fundamental constants. The total range in the number average diameters is slightly less than 3% of the mean of the means. For many applications, the use of standards based on these measurements would enhance the accuracy of size measurements for aerosols and colloids.

The 95% confidence intervals for some of the measurements barely overlap, raising the concern that some uncertainty components may have been underestimated or some measurement biases may have been overlooked. Possible reasons for the differences will be discussed including the slip correction for DMA, the work function of the EAB electrodes, determination of the physical edge of the particle for SEM, and the particle-substrate adhesion-force distortion for AFM. Another concern is the differences in the particle environments for the different measurements – two are aerosol measurements and two are based on the deposition of particles onto a surface. Improvements in these methods or the development of new techniques are important for progress in fundamental aerosol and colloidal research.

5IM.6

Assessment of Scanning Mobility Particle Sizer (SMPS) for Online Monitoring of Delivered Dose in an in Vitro Aerosol Exposure System. SRIPRIYA NANNU SHANKAR, Kiran Mital, Eric Le, Gregory S. Lewis, Arantzazu Eiguren-Fernandez, Tara Sabo-Attwood, Chang-Yu Wu, *University of Florida*

Real-time monitoring of dose delivered in a controlled manner is an important consideration for assessing aerosol toxicity. To address this, we propose the use of the Scanning Mobility Particle Sizer (SMPS) as a tool to estimate the delivered dose through the Dosimetric Aerosol in Vitro Inhalation Device (DAVID), which efficiently deposits particles after particle size amplification by water vapor condensation. We aerosolized CuO nanoparticles (25-55 nm) suspended in alcohol at different concentrations (0.01-10 mg/mL) for 5-30 min using a Collison nebulizer. Diluting the generated aerosols with air at a ratio of 1:3 (setup 1) yielded concentrations in the range of $3.65\times10^5\pm5.38\times10^5 – 1.76\times10^6\pm1.58\times10^5$ #/cm^3. On further diluting 1 LPM exiting setup 1 with 4.5 LPM of compressed air (setup 2), the concentrations reduced to $2.25\times10^4\pm8.58\times10^3 – 1.44\times10^5\pm3.78\times10^4$ #/cm^3. The deposition efficiencies determined by the ratio of number concentrations of particles exiting and entering DAVID, as measured by the SMPS for setups 1 and 2, were 31.0%±13.0% and 86.9%±8.6%, respectively. The real-time mass dose ($Dose_{SMPS}$) was estimated using particle diameter of average volume and number concentration from the SMPS measurements, while the delivered dose ($Dose_{ICP}$) was determined from the Cu concentrations analyzed by Inductively Coupled Plasma - Optical Emission Spectrometry (ICP-OES). The averaged ratio of $Dose_{SMPS}$:$Dose_{ICP}$ was 2.1±0.75 for setup 1 and 1.04±0.29 for setup 2, for nebulizer concentrations of 0.1-10 mg/mL. A linear trend was observed for $Dose_{SMPS}$ vs. $Dose_{ICP}$ with correlation of >0.99 for setup 1 and >0.89 for setup 2. Our study demonstrates that the SMPS can be used to monitor the delivered dose on a real-time basis. Controlled delivery of mass dose ranging from 0.4±0.02 to 90.3±12.0 µg/cm^2 can be attained within 30 min in a condensation-based particle growth exposure system by adjusting the nebulizer concentrations, aerosolization time, and dilution air.

5IM.7

A High Resolution Differential Mobility Analyzer with Extended Size Range for Viral Particle Studies. LUIS-JAVIER PEREZ-LORENZO, Jerzy Kozlowski, Juan Fernandez de la Mora, *Yale University*

Perez-Lorenzo et al. (J. Aerosol Sci. 151, 105658, 2021) have recently described a Differential Mobility Analyzer (DMA) producing very narrow mobility peaks (HWFM below 2%) with certain viral particles having diameters of up to 60 nm. Their DMA had an outer cylinder radius of 2 cm and an inner electrode converging conically with 3° up to an inner radius of 1 cm at the exit slit. Their limited size range may be theoretically extended to larger particles by decreasing the gap between both electrodes. However, earlier attempts with this strategy led to inferior resolution due to several possible causes. First, high concentricity is harder to achieve with a reduced inter-electrode gap. Second, at fixed sheath gas flow rate Q, a reduced gap increases flow speed and Reynolds number, favoring an earlier turbulent transition. The successful model here tested was built with especial concentricity requirements. It also used a conical inner electrode converging at 0.5° up to an inner radius of 1.6 cm at the outlet slit. Finally, a new scheme to mount the laminarization screens was implemented. The DMA has been tested with several viral particles, including the 29 nm bacteriophage PhiX174. The peak width decreases at increasing sheath gas flow rate Q up to a Reynolds number slightly above 1900, where FWHM approaches 50. The instrument has been used to investigate several relatively large viral particles, including the bacteriophages T2 and T4. Hogan et al. have reported that T4 is fragmented during the electrospraying process leaving only an ~80 nm capsid. We confirm their finding in sprays from 10 mM aqueous ammonium acetate. However, a larger and apparently intact ~100 particle is observed when spraying from deionized water. The DMA achieves an electric field of 30 kV/cm at which the mobility of T2 and T4 is field dependent.

5PC.1 (Invited)

The Role of Water Vapor on Photo-bleaching of Organic Aerosol Particles. RACHEL O'BRIEN, Hongmin Yu, Alexandra Klodt, Laurel Nicks, Natalie Warren, Churchill Wilkinson, Marley Adamek, Monica Dibley, Christopher Lim, Carolyn Jordan, Bruce Anderson, Christopher Cappa, Jesse Kroll, Sergey Nizkorodov, *University of Michigan*

Organic aerosol particles can influence the climate through either directly absorbing or scattering solar radiation or by acting as nuclei for cloud droplets. Some aerosol particles are dominantly scattering while others contain organic molecules that can absorb solar radiation in the visible region, termed brown carbon (BrC). We still have large uncertainties in the magnitude of these climate effects and a better understanding of the possible removal processes is needed. One removal process is photolysis, where absorption of solar radiation leads to fragmentation of the organic molecules and the loss of particle mass and/or color. However, the photolysis rates and the overall extent of mass that can be removed via direct photolysis in laboratory experiments does not match what is used in models and often differs from ambient measurements. In particular, the role of water vapor, and its impact on the viscosity of the particles during photo-aging is an area of uncertainty. In addition, longer term photo-aging studies point to multi-generational products that can form in the particles, influencing their lifetime and behavior. Here, we will combine results from work in our lab looking at photolysis at different relative humidity values of biogenic secondary organic aerosol as well as BrC from both biomass burning organic aerosol and urban secondary organic aerosol to evaluate gaps in our ability to predict the longer-term fate of these particles in the atmosphere.

5PC.2

Parametrization of Acid-Base Dissociation for Atmospheric Nanoparticle Growth Predictions. PAULUS BAUER, Sabrina Chee, Nanna Myllys, James Smith, Kelley Barsanti, *University of California, Riverside & Irvine*

Measurements and models have shown that growth rates of new particles are often higher than can be explained by the condensation of sulfuric acid (H_2SO_4) alone. In particular, organic compounds are thought to play some role in these higher growth rates. To contribute to the growth of ambient nanoparticles, organic compounds must be of sufficiently low volatility to overcome the Kelvin effect. Organic compounds with very low volatility can be formed through chemistry in the gas phase (e.g., autoxidation) and in/on particles (e.g., acid-base reactions and organic salt formation). The overall growth rate of atmospheric nanoparticles can be calculated as the sum of the growth rates due to condensation of H_2SO_4 and low-volatility organic compounds, reactive uptake, and formation of organic salts. However, due to uncertainties in these processes and the parameterizations used to represent them in models, agreement between measured and modeled growth has been elusive even under controlled conditions.

Here we used computational chemistry and laboratory experiments to test the applicability of bulk phase aqueous acid and base dissociation constants (pK_A and pK_B, respectively) for representing chemical processes in and on atmospherically relevant nanoparticles. Given the dependence of dissociation constants on ionic strength and solvent dielectric constant, there is a range of particle sizes and compositions for which aqueous bulk phase pK_A and pK_B values are likely insufficient to represent relevant acid-base chemistry. For such cases, we apply a parameterization that modifies the dissociation constant based on effects of size and solvent composition. To evaluate the sensitivity of environmental predictions, we implement the newly developed parameterization to model the role of organic salt formation in the growth of atmospheric nanoparticles. The extent to which organic salt formation contributes to nanoparticle growth, and consequently the growth rate, is important for predicting aerosol-climate interactions and health effects.

5PC.3
Constraints on the Role of Laplace Pressure in Multiphase Reactions and Viscosity of Organic Aerosols.

SARAH PETTERS, *Aarhus University*

Aerosol chemistry has broad relevance for climate and global public health. The role of interfacial phenomena in condensed-phase aerosol reactions remains poorly understood. In this work, liquid drop formalisms are coupled with high-pressure transition state theory to formulate an expression for predicting the size-dependence of aerosol reaction rates and viscosity. Insights from high-pressure synthesis studies suggest that accretion and cyclization reactions are accelerated in 3–10-nm particles smaller than 10 nm. Reactions of peroxide, epoxide, furanoid, aldol, and carbonyl functional groups are accelerated by up to tenfold. Effective rate enhancements are ranked as: cycloadditions >> aldol reactions > epoxide reactions > Baeyer-Villiger oxidation >> imidazole formation (which is inhibited). Some reactions are enabled by the elevated pressure in particles. Viscosity increases for organic liquids but decreases for viscous or solid particles. Results suggest that internal pressure is an important consideration in studies of aerosol physical chemistry and microphysics.

5PC.4
Ozonolysis of Aqueous Iodide at the Air-Water Interface Studied by Single Microdroplet Mass Spectrometry.

ALEXANDER PROPHET, Kevin R. Wilson, *Lawrence Berkeley National Laboratory*

Iodide ozonolysis occurring in seawater and aqueous aerosol is a major sink for atmospheric ozone and a source of molecular iodine. The exceptionally fast reaction rate between ozone and iodide, together with the strong surface-propensity of aqueous iodide, suggests the importance of reactivity at the air-water interface in this system. However, previous reports differ in describing the surface composition and the relative contributions of surface and bulk reactions. Here, the ozonolysis of aqueous iodide in microdroplets is studied using a quadrupole electrodynamic trap (QET) coupled with single-droplet paper-spray mass spectrometry. A kinetic model is constructed to account for dynamic concentrations and reactions at the surface and in the bulk, leading to the production of aqueous and gas-phase products. This description allows for a detailed understanding of competitive surface-processes and their relation to the bulk that cannot be explained by widely used resistor model limiting cases. Experimental and modeling results indicate that surface-depletion of both ozone and iodide at the air-water interface critically determines the overall kinetics observed. Analytical expressions describing coupled reagent depletion at the interface are derived and applied to compute surface-specific uptake coefficients. A kinetic analysis of the results suggest that the experiments conducted, together with simulation, provide a novel approach to examining physical surface-processes such as desorption of ozone and solvation of interfacial ions.

5PC.5

Optical-Trapping, Single-Particle Reactor for the Study of Surface and Heterogeneous Chemistry of Mercury. CHUJI WANG, Yukai Ai, Yong-Le Pan, Gorden Videen, *Mississippi State University*

Mercury is a neurotoxin that impacts human health and the health of ecosystems globally. Mercury exists in the atmosphere in three major forms: elemental mercury, gaseous oxidized mercury, and particulate mercury. Gas-phase mercury chemistry has been extensively studied through some key kinetic constants are being measured. However, the heterogeneous and surface chemistry of mercury has been much less studied due to its complexity and experimental difficulties in accurate measurements. Current studies of atmospheric mercury predominantly use flow-tubes or reaction vessels that inevitably suffer the wall-effect and surface interferences.

We create a single-particle reactor (SPR) using optical trapping to mimic single, particulate mercury particles freely suspended in the atmosphere. We investigate reactions and equilibrium processes on the surface of mercury compound-contained single-particles that are exposed to ozone, UV light in a range of relative humidity. In particular, we mixed HgX_2 (X_2=Cl_2, Br_2, or ClBr) with single-wall carbon nanotube particles and trapped a single mercury compound contained particle (a SPR) in an airtight chamber under controlled condition (concertation of ozone, relative humidity, UV light). We explored multiphase chemical reactions via measuring the time- and position-dependent Raman spectra of the particle. The Raman spectra revealed details of heterogeneity of the mercury compounds in the particle, time-evolution of the particle surface, reaction of the mercury compounds with ozone, and photochemistry effect. We present some preliminary results from this study.

5PC.6

Collisions of Picoliter Droplets With a Surface. LAUREN MCCARTHY, Jim Walker, Jonathan P. Reid, *University of Bristol*

Droplets colliding with surfaces undergo dynamic processes including wetting and oscillating. The precise evolution of these processes is dependent on the properties of the droplet such as its size, surface tension and viscosity, as well as the properties of the surface itself. Studies of droplets colliding with surfaces have largely focused on microliter sizes, using a laser or imaging the system. As the droplet size decreases, high frame rate imaging is required to capture images of droplet oscillations with sufficient time resolution. We have developed a system for observing the dynamics of picoliter droplets, capturing 100,000 frames per second (10 µs). Observed oscillations and contact angle were used to calculate droplet surface tension. Our results indicate that, due to the interference of wetting of droplets this size, accurate determination of surface tension using this method is dependent upon a high contact angle. A high contact angle was achieved using a hydrophobic Teflon surface and high surface tension droplets (> 50 mN m^{-1}). The wetting of low surface tension water-ethanol droplets (< 25 mN m^{-1}) on a hydrophilic borosilicate surface is well modelled by Tanner's law for droplets of this size.

5PC.7

The Use of Transmission Electron Microscopy with Scanning Mobility Particle Size Spectrometry for an Enhanced Understanding of the Physical Characteristics of Aerosol Particles Generated with a Flow Tube Reactor. EMMA TACKMAN, Devon Higgins, Murray Johnston, Miriam Freedman, *The Pennsylvania State University*

Microscopic examination of aerosol particles provides insight into physical characteristics such as specific shape, phase separation if present, and qualitative speciation, all of which have significant implications for particle phase atmospheric chemistry. The scanning mobility particle sizer (SMPS) is a common tool for measuring the size of aerosol particles but must be paired with other techniques for information about particle morphological attributes which are inaccessible to a SMPS alone. Transmission electron microscopy (TEM) is one such complementary technique whereby, after impaction onto a substrate, individual particles can be observed with high throughput. An often-overlooked aspect of aerosol characterization is the influence the substrate which may cause physical deformation to a particle. Deformation must be considered when comparing data from a SMPS, which assesses particles suspended in a gas flow, to the results of a substrate-supported measurement.

Here, we explore the relationship between SMPS- and TEM-derived aerosol measurements; particles containing ammonium sulfate and α-pinene SOA generated in a flow tube under varying conditions were measured by SMPS and subsequently impacted onto a substrate and examined using TEM. Using the same particles for both measurements facilitated the direct comparison of the two techniques as well as the ability to observe the influence of the substrate. We found that impacted ammonium sulfate particle diameters increased by +0% to +30% when compared to the suspended mobility diameters, an unexpectedly wide range for a single component system. SOA-coated particles showed an even wider range of diameter deviations from –34% to +60%. Morphology was also highly variable in coated samples where between 18% and 98% of particles displayed obvious phase separation. The surprisingly high level of diversity in morphology and the deviation between suspended and impacted aerosols implies that great care should be taken when comparing data sets from disparate sources.

5UA.1

Modeling Formation of Secondary Organic Aerosol from the Photooxidation of Naphthalene. SANGHEE HAN, Myoseon Jang, *University of Florida*

A large portion of atmospheric organic aerosol is secondary organic aerosol (SOA) produced from the oxidation of hydrocarbons. In addition to VOC precursors, the oxidation of intermediate volatility organic compound (IVOC) is known to be an important source to form SOA in urban environments. Naphthalene, an IVOC, is the most abundant polycyclic aromatic hydrocarbon. This naphthalene is emitted from diesel combustions and biomass burning and is found to produce SOA with a high yield. However, both the gas oxidation mechanism of naphthalene and its SOA formation potential under varying atmospheric conditions are not well understood. In this study, the UNIfied Partitioning Aerosol phase Reaction (UNIPAR) model, which predicts the SOA formation via multiphase reactions of hydrocarbons, is extended to simulate naphthalene SOA. A near explicit mechanism for the atmospheric oxidation of naphthalene is established based on the structure-activity relationship, the characterization of naphthalene oxidation products with PTR-TOF-MS, and previously reported gas mechanisms. The oxygenated products predicted with the resulting explicit mechanisms are classified into volatility-reactivity based 2D lumping species to generate physicochemical parameters and the mathematical equation to form stoichiometric coefficients. The resulting parameters and equations are applied to estimate the SOA formation that is predicted by multiphase particle partitioning and emerging aerosol phase reactions in UNIPAR. The suitability of the model is demonstrated by comparing model simulation with SOA chamber data generated from the photooxidation of naphthalene under varying temperature, humidity, NO_x levels, and seed conditions in a large outdoor photochemical smog reactor.

5UA.2

Secondary Particulate Matter Formed in a Flow Reactor from Gas- and Aqueous-phase Chemistry of Ambient Air in Riverside, California. NINGJIN XU, Alexander B. MacDonald, Xuanlin Du, Roya Bahreini, Don Collins, *University of California, Riverside*

Ambient particulate matter (PM) is a highly complex mixture of different-sized solid and liquid particles originating from both anthropogenic and natural sources. Secondary PM contributes a significant fraction of total PM in both urban and remote areas. However, identifying and quantifying the importance of specific precursors or precursor categories (e.g. volatile chemical products and biogenic VOCs) on measures of environmental and health-related impacts represent one of the most challenging areas of control of secondary PM. Over the last decade or so, the use of oxidation flow reactors (OFRs) to study PM formation in ambient air has grown rapidly because of their portability and their ability to provide high-time resolution measurements in dynamic environments. Use of OFRs has been almost exclusively focused on studying products and yields from gas-phase oxidation of VOCs with little or no liquid water present. Riverside, CA is located on the eastern side of the South Coast Air Basin that includes Los Angeles and often experiences high PM concentrations. In the spring of 2022, the first of a series of field studies aimed at understanding the sources of PM in different regions of California was conducted in Riverside. The Aerosol Production and Processing of Aerosols (APPA) OFR was operated continuously for one month to measure the amount and properties of secondary PM formed through both gas- and gas+aqueous-phase oxidation. The results are used to characterize short-term variability in PM precursors and to explore the roles of different formation pathways. The secondary PM formed in the OFR was measured with a scanning mobility particle sizer and a mini time-of-flight aerosol mass spectrometer (mAMS). We will provide an overview of the experimental approach and will present initial results from the field study.

5UA.3

PM2.5 Impacts from the Historic Ship Backlog at the Ports of Los Angeles and Long Beach. XIANG LI, Ranil Dhammapala, Melissa Maestas, Nico Schulte, Scott A. Epstein, *South Coast Air Quality Management District*

The South Coast Air Basin (Basin), which includes the greater Los Angeles metropolitan area, has had significant challenges meeting federal PM2.5 standards. In 2021, the basin-maximum PM2.5 concentration exceeded the 24-hour PM2.5 federal standards on 18 days in November and December, the highest number of days recorded in those months in the past ten years. Preliminary studies suggest that both meteorological conditions and additional emissions may have played a role. In November 2021, because of the congestion caused by cargo backlogs, over 150 container ships were present off the coast and at berth in the Port of Los Angeles and the Port of Long Beach each day. To reduce the impact of ship emissions on the Basin, the Marine Exchange of Southern California modified the queuing process to encourage ships to wait more than 50 or 150 miles from the coast depending on latitude. However, the authors are not aware of any studies that have been conducted to quantify the potential effectiveness of this new queuing process in reducing PM2.5 in the Basin.

To assess the potential impact of the additional ship emissions on air quality in the Basin, we simulated atmospheric transport of ship emissions from a grid of 1302 ship emission locations over the ocean areas, spanning from the Los Angeles and Orange County coastline to over 200 miles away from the coast. At each location, 48-hour HYSPLIT forward trajectories starting every two hours on each day of 2021 were calculated. We calculated the fraction of trajectories reaching the Basin from each location to assess the potential of the location to affect PM2.5 concentrations in the Basin. Time- and location-dependent planetary boundary layer heights were used to remove trajectory points above the Basin's planetary boundary layer. We used NAM-12 km forecast as the meteorological input, and the spatial- and time-dependent plume rise heights of the simulated ship emissions were estimated using EPA's AERMOD. In addition, we ran sensitivity tests for many other factors that could affect the results, including the HYSPLIT vertical motion mode, the time resolution of the model run, and the input meteorological field.

Results show that the plume transport to the Basin from locations 50-150 miles offshore is rare, which indicates that the new queuing process adopted by the Marine Exchange will help reduce the transport of PM2.5 and precursors emitted by ships to the Basin. In addition, the impact from emissions located 25-50 miles offshore is much lower in winter than in summer. Finally, the Riverside/San Bernardino metropolitan area is mainly affected by emissions south of the Palos Verdes peninsula, while Los Angeles County is primarily influenced by emissions north of the Palos Verdes peninsula.

5UA.4

Revealing Nighttime Construction-related Activities from a Distributed Air Quality Sensor Network. Jintao Gu, Bo Yuan, Jiajun Gu, Shaojun Zhang, Ye Wu, K. MAX ZHANG, *Cornell University*

In this study, we analyzed the spatial and temporal patterns of coarse PM (PMc) levels in a 165-node PM monitoring network in Xi'an, China, covering both urban and rural areas in the municipality. We employed a novel technique called network analysis, focusing on peer-to-peer comparison within the network. The network analysis revealed the existence of an unknown, nighttime local driver unique to the urban areas, causing the highest PMc concentrations in the city. Through further analysis using satellite-based aerial imagery and data-mining of internet resources, we confirmed with high confidence the local driver to be related to construction emission sources, both at the construction sites and from diesel traffic transporting construction materials. The peak PMc concentrations from late night to early morning often triggered both noise and air pollution complaints from local residents. Based on our findings, we also recommend policy makers to re-assess the construction-related policies by considering the trade-offs among safety, air quality and noise.

5UA.5

Comprehensive Chemical Characterization of Particle Emissions from Urban Cured-In-Place-Pipe Installations. BRIANNA PETERSON, Ana Morales, Christopher P. West, Jay Tomlin, Felipe Rivera-Adorno, Steven Sharpe, Yoorae Noh, Pritee Pahari, Andrew Whelton, Alexander Laskin, *Purdue University*

Cured-in-place-pipe (CIPP) installation of plastic pipes is the most common and widely used method to repair damaged sanitary and stormwater sewers by the installation of a new plastic pipe inside an existing damaged pipe. The installation procedure involves the chemical manufacture of a new plastic pipe inside of an existing damaged pipe by blowing either hot air or steam through a resin-coated pipe liner, resulting in the generation and direct atmospheric release of complex multiphase mixtures of volatile, semi-volatile, and solid organic compounds. Many reports have noted that the emissions contain hazardous air pollutants, known endocrine disrupting compounds, and known carcinogens, where some exceed regulatory limits. Moreover, the low volatility and high viscosity of chemical components in these emissions results in primary and secondary organic aerosols discharged into the atmospheric environment at CIPP installation sites. While studies have investigated the gas-phase CIPP emissions, the condensed-phase emissions are yet to be fully explored. Our investigation focuses on the detailed chemical composition of condensed-phase emissions from CIPP installation, utilizing both mass spectrometry and chemical imaging techniques to determine chemical composition and physical properties at the bulk and single particle level. This work provides a detailed description on the chemical composition of condensed-phase components released during CIPP manufacture, which is important in evaluating their contributions to urban pollution.

5UA.6

New Particle Formation from the Road Surface. HINRICH GROTHE, Ayse Nur Koyun, Juergen Gratzl, Camile Bocaniciu, Hemanjali Vemuri, *TU Wien, Institute of Materials Chemistry, Vienna, Austria*

Atmospheric aerosols are key part of the urban environmental system, as they influence global and regional climate and impact air quality. Supersaturated vapors in urban atmosphere can form new liquid or solid particles under specific, suitable conditions. This process is known as new particle formation (NPF) or secondary gas-to-particle formation. Recent publications have shown that the road itself can be source of NPF both during routine use (Khare et al. 2020) and during maintenance (Weiss et al. 2018). In specific laboratory experiments we have determined the strength of the source and have collected respective aerosols at a construction site with the aim to differentiate NPF from soot and other primary particles originating from bypassing traffic and the road paving machines.

References

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5UA.7

The Impact of the Sea Breeze on Particulate Matter Chemical Composition and Concentration in Houston. CHUN-YING CHAO, Wei Li, Yuxuan Wang, Robert Griffin, *Rice University*

It is crucial to understand the factors that control air quality in coastal regions because approximately half of the population of the United States lives in such areas. The local sea-land breeze plays an important role in coastal air quality because it circulates pollutants between coastal/urban and marine areas, potentially causing the accumulation of pollutants. Most previous studies focused on ozone concentration in these areas. However, particulate matter (PM) is another important air pollutant that warrants investigation. To understand the complicated interactions between coastal urban air quality and local sea-land breezes, we analyzed the historical PM data from Houston, Texas, which is the fourth most populous city in the United States. We used k-mean algorithm to analyze wind data from Houston and successfully separated synoptic wind clusters and a local sea breeze cluster. Additionally, we performed principal component analysis (PCA) on PM composition data for June, July, and August 2010-2019 from a monitoring site 5 km south of the industrialized Houston Ship Channel, resulting in the source apportionment of PM for each of the meteorological clusters. The results demonstrate that on southerly wind and local sea breeze days, the PM2.5 concentrations are ~30% higher than under other wind patterns. Under southerly winds, 29% of PM was attributed to road dust and 20% to heavy oil/combustion. In contrast, on days identified as being impacted by sea breezes, 33% of PM was attributed to motor vehicles and 20% to crustal sources and fresh sea salt. This study provides an example of how land-sea breeze can affect PM concentrations and compositions in a coastal city.

6AC.1

Secondary Organic Aerosol Formation from Photooxidation of Oxygenated Monoterpenes in Simple and Complex Chemical Systems.

CELIA FAIOLA, Farzaneh Khalaj, Shan Gu, Véronique Perraud, Leah Williams, Jordan Krechmer, Andrew Lambe, *University of California, Irvine*

Biogenic volatile organic compounds (BVOCs) from vegetation are major contributors to secondary organic aerosol (SOA) production worldwide. Oxygenated monoterpenes are commonly observed in many plant emission profiles with relatively low contribution to the total emissions, but they dominate emissions from some plant types, including shrub species in southern California's coastal sage scrub ecosystem. Very few studies have systematically characterized SOA production and composition from these BVOCs. This presents a gap in our ability to predict SOA production in a future climate where drought-tolerant shrubs will likely experience large range expansion into new areas. This study investigated SOA formation and composition from the major oxygenated terpenes that have been observed in plant emissions across the globe: camphor, 1,8-cineole, borneol, and bornyl acetate. In these experiments, SOA was generated via photooxidation in an oxidation flow reactor (OFR). Continuous monitoring of ozone and particle size distributions was conducted using an ozone monitor (2B Technologies) and a custom-built scanning mobility particle sizer (SMPS), respectively. SOA composition was characterized offline using a high-resolution Q Exactive Orbitrap mass spectrometer (ThermoScientific) using SOA samples collected on Teflon filters. We also compared composition measured with an aerosol mass spectrometer (HR-ToF-AMS, Aerodyne) for SOA generated from real coastal sage shrub emissions versus oxygenated and aliphatic monoterpene standards. SOA mass yields of oxygenated monoterpenes were compared to alpha-pinene as a reference system. Calculated yields from lowest to highest were bornyl acetate < alpha-pinene < 1,8-cineole/borneol < camphor. Hierarchical clustering of the AMS data demonstrated that the real shrub SOA (dominated by oxygenated monoterpenes) was equally dissimilar from SOA formed from standards of oxygenated and aliphatic monoterpenes. This study sheds light on SOA formed from oxygenated terpenes in both simple and complex chemical systems, and will help improve predictions of SOA production in a future climate.

6AC.2

Molecular and Structural Characterization of Isomeric Compounds in Atmospheric Aerosols Using Ion Mobility Spectrometry – Mass Spectrometry.

CHRISTOPHER P. WEST, Daniela Mesa Sanchez, Ana Morales, Yun-Jung Hsu, Jackson Ryan, Andrew Darmody, Lyudmila Slipchenko, Julia Laskin, Alexander Laskin, *Purdue University*

Secondary organic aerosol (SOA) formed through multi-phase atmospheric chemistry makes up a large fraction of airborne particles. The chemical composition, molecular structures, and emission sources are complex and vary between different SOA samples, complicating their identification in complex mixtures. In this work, we utilize drift tube ion mobility spectrometry (DTIMS) with quadrupole time-of-flight mass spectrometry (Q-TOF-MS) detection for rapid gas-phase separation and multi-dimensional characterization of isomers in two sets of biogenic SOA samples (D-limonene, LIM/O_3 and α-pinene, APIN/O_3). All samples were ionized using electrospray ionization (ESI) and acquired in both positive and negative ion modes. The IMS-derived collision cross-sections in nitrogen gas (${}^{DT}CCS_{N2}$) for isomer components in the samples were obtained using multi-field measurements. Novel ion multiplexing/high-resolution demultiplexing strategies were used to increase sensitivity and mobility baseline resolution, which helped reveal several conformational and isomeric structures for the measured ions. For LIM/O_3 and APIN/O_3 SOA samples, we report significant structural differences of the isomer structures complemented by theoretical calculations. The average ${}^{DT}CCS_{N2}$ values for monomeric structures measured as $[M+Na]^+$ ions are 1.2% higher than $[M-H]^-$ counterparts, meanwhile, dimeric and trimeric isomer structures in both SOA samples where 3.5% - 7% higher for $[M-H]^-$ than their $[M+Na]^+$ ion structures, respectively. Therefore, characteristic ${}^{DT}CCS_{N2}$ values of isomers in aerosols depend strongly on the mode of polarity and ionization mechanism in ESI. Additionally APIN/O_3 monomers and dimers exhibit larger ${}^{DT}CCS_{N2}$ values (~1-4% deviation) than LIM/O_3 counterparts owing to their bulky organic gas-phase ion structures, comprising cyclobutane ring with extended methyl (-CH_3) groups in APIN/O_3 compared to acyclic branched ketone groups in LIM/O_3 system. We provide, for the first time, detailed molecular and structural descriptors for accurate detection and annotation of structural isomers in complex SOA mixtures, which are common in atmospheric chemistry.

6AC.3

OH-initiated Photooxidation of Gas-phase Monoterpene-derived Hydroxy Nitrates. NGA LEE NG, Yuchen Wang, Masayuki Takeuchi, *Georgia Institute of Technology*

Monoterpene-derived hydroxy nitrates (MT-HNs) are first-generation products formed from the oxidation of monoterpenes by OH or NO_3 radicals. The subsequent chemical fates of MT-HNs can determine their roles in acting as a permanent sink or temporary reservoir of NO_x, which can further impact NO_x recycling and O_3 formation. However, research on subsequent reaction rates and mechanisms of atmospherically relevant MT-HNs is limited. In this work, we investigated the gas-phase OH-initiated photooxidation of three synthetic HNs derived from α-pinene, β-pinene, and limonene through chamber experiments. The OH reaction rate constants at 297 K measured relative to cyclohexane for these three MT-HNs are in the range of 5.73–11.1 10^{-11} cm^3 $molecule^{-1}$ s^{-1}. We also found that the photooxidation of MT-HNs can lead to aerosol formation with high SOA yields. To probe the effects of peroxy radical (RO_2) fate on aerosol formation, “RO_2+NO dominant” and “RO_2+RO_2/HO_2 dominant” experiments are performed. The SOA yields in the “RO_2+NO dominant” experiments (~3-60%) are much lower than “RO_2+RO_2/HO_2 dominant” experiments (~80-150%) with similar initial MT-HN concentrations, which can be explained by the products formed via the RO_2+RO_2/HO_2 pathway are less volatile than those formed via the RO_2+NO route. Photooxidation mechanisms in both gas and particle phases were proposed based on major products identified by high-resolution time-of-flight chemical-ionization mass spectrometer (HR-ToF-CIMS) coupled with the filter inlet for gases and aerosols (FIGAERO). The major products without nitrooxy groups were only identified in “RO_2+RO_2/HO_2 dominant” experiments. We proposed that these compounds were mainly formed via H-abstraction or H-shift, followed by epoxide formation with the loss of NO_2. Results from this study provide the fundamental data to evaluate the contributions of OH-initiated photooxidation MT-HNs as NO_x reservoirs/sinks, and their possible influence on NO_x recycling and SOA formation.

6AC.4

Chemical and Optical Properties of SOA from the Oxidation of Volatile Organic Compound Mixtures. YUMENG CUI, Kunpeng Chen, Ying-Hsuan Lin, Roya Bahreini, *University of California, Riverside*

The chemical and physical properties of secondary organic aerosols (SOA) have been widely studied by environmental chamber experiments, and the results have been parameterized in atmospheric models to help understand their radiative effects and climate influence. While most chamber studies from the past decades investigated the aerosol formed from a single volatile organic compound (VOC) in batch mode, the potential interactions between reactive intermediates derived from VOC mixtures are not well understood. In this study, we investigated the SOA formed from pure and mixtures of biogenic (longifolene and α-pinene) and anthropogenic (1-methylnaphthalenen and phenol) VOCs using continuous-flow, high-NO_x photooxidation chamber experiments to better mimic ambient conditions. Optical properties, including single scattering albedo (SSA), mass absorption coefficient (MAC) and refractive index (RI) at 375nm, and chemical properties, including the contribution of organonitrate ($RONO_2$) and nitro-organic (RNO_2) compounds, and the molecular structure of the major chromophores, were explored. Source apportionment models were used to simulate the fractions of particle-phase products from biogenic vs. anthropogenic VOCs. Subsequently, these fractions were combined with the MAC values of pure SOA to predict the MAC of the mixture SOA. Our results show that, in multi-VOCs systems, the scattering biogenic SOA weakened the absorption from aromatic SOA; the discrepancies between the predicted and measured mixture SOA MAC varied among different VOC systems, indicating the potential formation of unique compounds in multi-VOCs experiments. The aerosol mass spectrometer (AMS) results showed the formation of $RONO_2$ and RNO_2 compounds in all experiments, with the fraction of these nitrogen-containing compounds varying in different systems. Time-integrated aerosol samples collected at the end of the experiments analyzed with offline instruments revealed that RNO_2 compounds are the major light-absorber in the 280-400nm range in both aromatic VOC systems. Overall, this study highlights the importance to consider the presence of multi-VOCs when estimate ambient SOA chemical and optical properties.

6AC.5

Secondary Organic Aerosol Mass Yields and Composition from NO3 Oxidation of α-pinene and Δ-carene: Effect of RO2 Radical Fate. DOUGLAS DAY, Juliane Fry, Hyun-Gu Kang, Jordan Krechmer, Benjamin Ayres, Natalie Keehan, Samantha Thompson, Weiwei Hu, Pedro Campuzano-Jost, Jason Schroder, Harald Stark, Marla DeVault, Paul Ziemann, Kyle Zarzana, Robert Wild, William Dubè, Steven S. Brown, Jose-Luis Jimenez, *CIRES, University of Colorado, Boulder*

Dark chamber experiments were conducted to study SOA formed from α-pinene and Δ-carene oxidation by NO_3 under different peroxy radical (RO_2) fate regimes: RO_2 + NO_3, RO_2 + RO_2, and RO_2 + HO_2. SOA mass yields from α-pinene oxidation were <1-25% and strongly dependent on OA mass up to ~100 $\mu g\ m^{-3}$. Yields from Δ-carene were consistently higher, ranging ~10-45% with some dependence on OA for <25 $\mu g\ m^{-3}$. Explicit kinetic modeling including vapor wall-losses was conducted to enable comparisons across precursors and RO_2 fate regimes, and to determine atmospherically-relevant yields. SOA yields were similar across nominal RO_2 fate regimes, and thus the Volatility Basis Sets constructed were independent of the chemical regime. Elemental O/C ratios were ~0.4-0.6 (including nitrate groups) and nitrate:organic mass ratios ~0.16 for both monoterpenes in all regimes. A previously reported empirical relationship for estimating particle density using elemental ratios for non-nitrate containing OA, was shown to be applicable to organic nitrate-rich SOA after adaptation.

Observations suggest that Δ-carene more readily forms low-volatility gas-phase highly oxygenated molecules (HOMs) than α-pinene, which primarily forms volatile and semi-volatile species. The similar Δ-carene SOA yields across regimes, high O/C ratios, and presence of HOMs, suggest that unimolecular and multi-step processes such as alkoxy radical isomerization and decomposition may play a role in SOA formation from Δ-carene. The scarcity of peroxide functional groups (14% of C10 groups carried a peroxide group in one RO_2+RO_2 test experiment) appears to rule out a major role for auto-oxidation and organic peroxide formation. The substantially lower SOA yields for α-pinene suggest such pathways are less available for this precursor. The marked and regime-robust difference in SOA yield from two monoterpenes suggests that in order to accurately model SOA production in forested regions, the chemical mechanism must feature some distinction among different monoterpenes.

6AC.6

Estimates of IEPOX Based SOA Formation in CMAQ 5.3.2 Using Updated Kinetics and Thermodynamics. JAIME GREEN, Yuzhi Chen, Jason Surratt, William Vizuete, *University of North Carolina at Chapel Hill*

Field and laboratory measurement data have shown the importance of an aerosol's physiochemical properties in determining its interactions with gas-phase oxidation products derived from biogenic volatile organic compound (BVOC) emissions and on the formation and evolution of secondary organic aerosols (SOA), with implications on climate and air quality. Recent flow tube and smog chamber experiments systematically generated SOA and were subsequently collected by a particle-into-liquid sampler (PILS) for time-resolved chemical measurements. PILS samples were then analyzed for SOA constituents by either reverse-phase liquid chromatography (RPLC) or hydrophilic liquid interaction chromatography (HILIC) coupled to electrospray ionization-high resolution-quadrupole-time-of-flight mass spectrometry (ESI-HR-Q-TOFMS) and inorganic aerosol constituents by ion chromatography (IC). These experimental systems have produced new insights on how acidity, organic water, and phase state alters the formation of isoprene epoxydiols (IEPOX)- derived SOA. IEPOX-derived SOA formation processes are not well represented in the current Community Multiscale Air Quality Model (CMAQ) model and could result in a significant under-prediction of the production of organic sulfur, affecting multiphase reactivity, phase state, aerosol growth, and reactive uptake of other chemical species. This work describes the use of the F0AM-CMAQ box model which utilized experimental data to evaluate and develop modifications to the existing CMAQ model, leading to CMAQ model simulations for the model year of 2013, for the domain covering the Southeastern US. The F0AM-CMAQ model is based on the Framework for 0-D Atmospheric Modeling (F0AM) model, CMAQ 5.3.2, integrating the inorganic aerosol thermodynamic equilibrium model (ISORROPIA) and the Aerosol Inorganic-Organic Mixtures Functional Groups Activity Coefficients model (AIOMFAC) with the purpose of determining the acid-base activity of the components of the aerosols at varying percentages of relative humidity. Based on the 0D box model comparison results, a new set of implicit parameters for IEPOX SOA formation will be developed for CMAQ and compared with current implementation of SOA formation, testing differences between predicted particle size, glass transition temperature for the southeastern US model domain. The parameter set will also utilize the application of the AIOMFAC thermodynamic model to determine the chemical and physical properties of aerosols in CMAQ based on the aerosol chemical components. These model runs will guide future updates to the CMAQ model related to isoprene derived SOA.

6AC.7

Elucidation of the Structures and Formation Mechanism of Dimer Esters in α-Pinene and β-Pinene Secondary Organic Aerosol. CHRISTOPHER KENSETH, Nicholas Hafeman, Samir Rezgui, Yuanlong Huang, Nathan Dalleska, Brian Stoltz, John Seinfeld, *California Institute of Technology*

Multifunctional dimer esters have been identified using advanced mass spectrometric techniques as significant components of secondary organic aerosol (SOA) formed from oxidation of α-pinene and β-pinene, and have been implicated as key players in new particle formation and growth, particle viscosity, and cloud condensation nuclei (CCN) activity. Particle-phase reactions of closed-shell monomers (e.g., esterification and peroxyhemiacetal/diacyl peroxide decomposition) and gas-phase reactions involving early-stage oxidation products and/or reactive intermediates [e.g., stabilized Criegee intermediates (SCIs), carboxylic acids, and organic peroxy radicals (RO_2)] have been advanced as possible dimer ester formation pathways. Due to a lack of authentic standards, however, structures of the dimer esters are inferred from accurate mass/fragmentation data and, therefore, mechanistic understanding of their formation remains unconstrained. Here, informed by detailed structural analyses (MS and MS/MS, ^{13}C and ^{18}O isotopic labeling, and H/D exchange) from current and past work (Kenseth et al., *PNAS*, 2018), we synthesize the first authentic standards of the major dimer esters identified in SOA from ozonolysis of α-pinene and β-pinene and elucidate their formation mechanism from a series of targeted environmental chamber experiments using chemical ionization mass spectrometry (CIMS) and liquid chromatography/electrospray ionization mass spectrometry (LC/ESI-MS) for respective analysis of gas- and particle-phase molecular composition. Identification of the chemistry underlying dimer ester production provides a missing link tying the atmospheric degradation of α-pinene and β-pinene to the observed formation of low-volatility compounds capable of driving particle formation and growth.

6AC.8

Effects of Isoprene on Biogenic New Particle Formation from Pre-Nucleation to CCN Sizes. LEE TISZENKEL, Asadullah Shoaib, Yue Zhao, Yue Zhang, Shanhu Lee, *University of Alabama Huntsville*

New particle formation (NPF) from biogenic precursors is responsible for a large portion of the sub-micron particle loadings observed in the atmosphere. Oxidation of monoterpenes and their subsequent nucleation and growth are critical first steps to this process. However, the impact on nucleation from the interactions between monoterpenes and isoprene remains unclear. We present results from new particle formation experiments in the Tandem Aerosol Nucleation and Growth Environment Tube (TANGENT) using α-pinene and isoprene oxidized in the presence of ozone and hydroxyl radicals. Particle size distributions ranging from pre-nucleation clusters to CCN-active diameters were measured with a PSM (particle size magnifier) and nano-SMPS. Gas- and aerosol-phase HOMs (highly-oxidized molecules) were measured with CI-APi-TOF (chemical ionization-atmospheric pressure-time of flight mass spectrometer) attached to FIGAERO (a filter inlet for gas and aerosol sampling). Aerosol phase chemical composition measured with CI-APi-TOF was also compared with off-line LC-ESI-Orbitrap mass spectrometer measurements to provide insights into chemical speciation of newly formed particles. Background ammonia and amine concentrations inside the TANGENT were measured with an ethanol-CIMS (chemical ionization mass spectrometer). In this presentation, we will discuss the impact of isoprene on nucleation and growth rates. A direct relationship between HOMs and nucleation and growth rates was observed. Isoprene was found to dramatically increase formation rates of pre-nucleation clusters. Isoprene-only nucleation was observed with size distributions sharply dropping after 3 nm size bins. In the presence of both α-pinene and isoprene, suppression of nucleation rates was observed with the extent of the suppression proportional to the isoprene:α-pinene ratio. Isoprene did not have an effect on observed growth rates. These results serve to explain the presence of sub-2nm clusters combined with the lack of new particle formation events observed in field experiments conducted in isoprene-rich forests of the Southeastern United States and the Amazon.

6BA.1

Characterization of Single Fungal Aerosol Particles in a Reactive Atmospheric Environment Using Optical Trapping-Raman Spectroscopy. YUKAI AI, Chuji Wang, Yong-Le Pan, Gorden Videen, *Mississippi State University*

In current laboratory and field studies, aerosol samples are either collectively or individually placed on a substrate or in a sample holder for subsequent measurements that may experience signal interference from particle-surface contamination or modification. Here we applied a time-resolved, optical trapping-Raman spectroscopy (OT-RS) technique to characterize single, trapped bioaerosol particles under well-controlled reactive conditions that mimic the native state of particles in the atmosphere. We measured Raman spectra of seven different fungus samples using an OT-RS system, in which single fungal aerosol particles of tens of microns in size are trapped without photo-damage while relative humidity and ozone concentration around the particle were well controlled. We initially obtained Raman spectral fingerprints of seven different single-trapped fungal aerosol particles in air. We then measured time-resolved Raman spectra of the fungal aerosol particles trapped in air over a period of 40 minutes and characterized the temporal behavior of the trapped particles in terms of Raman band structure and intensity. We also measured time-resolved Raman spectra of the fungal aerosol particles exposed to ozone in a controlled concentration and relative humidity and compared the spectral features with those obtained when the single fungal aerosol particles were exposed to air. Results show that we not only observed time variations of the physical and chemical properties of single-trapped particles, but also specified several individual chemical function groups such as lipids and proteins that undergo chemical reactions with ozone. This work demonstrated that OT-RS is a powerful technology for characterization of physical, chemical, and biological properties of single bioaerosol particles in simulated atmospheric condition and for potential detection of single bioaerosol particles in the atmosphere using Raman spectral fingerprints.

6BA.2

Development of an Aggressive-Air Activity-based Air Sampling System for Collection of Bioaerosols in Outdoor Areas. JOHN ARCHER, M. Worth Calfee, Adam Hook, Robert Yaga, William Schoppman, Jerome Gilberry, *US EPA*

A wide-area intentional release of a biological agent such as *Bacillus anthracis* would require very complex and potentially daunting remediation efforts. There has been significant progress made in developing capabilities and preparedness to respond to indoor biological contamination incidents, particularly for relatively contained ones (e.g., single facilities). However, capabilities and an operational strategy for cleaning up the outdoor environment do not exist for a biological agent incident, and as such, represent a major preparedness gap. Characterization, determination of the extent of contamination, and clearance of remediated areas using current surface sampling methods may require unrealistic numbers of samples to be collected over a long time. EPA researchers have developed an aggressive air sampling system for contaminated outdoor surfaces following a wide-area release to be used in conjunction with surface sampling to cover larger areas in a shorter time period.

AACeSS (Activity-Based Aggressive-Air Contained Sampling System) is an innovative air sampling system developed by EPA for use in bioaerosol sampling following a wide area biological release. Initial research efforts evaluated a tent-based system, but the current version of AACeSS is a mobile cart-based sampling system used to collect bioaerosol samples from multiple outdoor surfaces, including grass, gravel, asphalt and concrete. This sampling cart uses a leaf blower as a means of disturbing the surface with aggressive air and captures resuspended particles through a connected negative air machine (NAM) outfitted with multiple filters. These air samples combined with personal activity-based sampling conducted with SKC Button Aerosol Samplers in the breathing zone of operators provide a measure of spores that could potentially be resuspended from surfaces and pose an inhalation hazard. Recoveries of spores in lab and field tests with AACeSS demonstrate its effectiveness in an outdoor environment. An overview of AACeSS development will be presented along with bioaerosol collection results from lab and field tests.

6BA.3

Effect of Barrier on Spatial Distribution of Simulated Respiratory Particles in a Room. MARIAH GNEGY, Chase Gohlke, Linsey Marr, *Virginia Tech*

In response to the COVID-19 pandemic, the CDC issued workplace guidelines to protect workers when social distancing (≥ 6 feet) is not feasible; a hazard control recommendation is to install physical barriers. In the absence of other control measures, barriers may not provide adequate protection to individuals within that space due to altered airflow induced by the barrier. The objective of this study was to quantify the impact of the barrier on the spatial distribution of different sized particles released from a nebulizer that simulated respiratory emissions produced by speaking. We constructed 108 passive sampling locations in a room and nebulized fluorescent particles of relevant sizes both with and without a barrier (located 18 inches from the nebulizer outlet) to observe the differences in particle distributions. We counted the number of particles deposited on slides at the sampling locations. The presence of a barrier resulted in a significant increase in the number of 0.5 µm particles on the side of the barrier where the nebulizer was located; there was also a significant increase of 0.5 µm particles on the sides of the barrier, indicating that the air that moved around the barrier transported these particles. At distances of 14 and 19 feet from the nebulizer, the barrier resulted in a higher number of 0.5 µm particles, implying that the barrier can lead to increased exposure for those situated far away from a barrier. There were no observable differences in the distribution of 6-µm particles within the room with vs. without the barrier. Lastly, 10 and 20 µm particles were too large to be influenced by the barrier. These results imply in the absence of other control measures, barriers may not serve as adequate protection to others in the room, depending on their location relative to the barrier.

6BA.4

Pollen Effects on Health and Cloud Formation. BRIANNA HENDRICKSON, Sarah Brooks, Yingxiao Zhang, Allison Steiner, *Texas A&M University*

Under humid atmospheric conditions, pollen grains released by plants can rupture creating pollen grain fragments referred to as subpollen particles (SPPs). Pollen grains and SPPs can be dispersed in the atmosphere and significantly contribute to the aerosol population by acting as ice nucleating particles (INPs) influencing cloud formation and precipitation. To understand the impacts of pollen and SPPs on health and climate, the meteorological conditions required for pollen grain emissions and pollen grain rupture need to be characterized. It is also critical to quantify the SPPs created from a single pollen grain. In this study SPP emission factors were determined for live oak, *Quercus virginiana*, ryegrass, *Lolium perenne*, and giant ragweed, *Ambrosia trifida*. Each species was evaluated using wind-driven SPP release experiments by exposing samples to constant relative humidity while cycling fans used to simulate winds. The SPP emission factors were $2.5\text{x}10^{16}\pm1.4\text{x}10^{16}$ to $1.2\text{x}10^{19}\pm6.5\text{x}10^{18}$ SPPs per acre for live oak, $2.7\text{x}10^{17}\pm8.9\text{x}10^{16}$ SPPs per acre for ryegrass, and $5.4\text{x}10^{18}\pm4.6\text{x}10^{18}$ SPPs per acre for ragweed. Additionally, SPPs and pollen grains for all three species were tested for their ability to act as INPs in immersion mode freezing and pollen grains were also evaluated as INPs in contact mode freezing. Freezing temperatures will be reported for SPPs in immersion mode freezing, pollen grains in contact mode freezing, and pollen grains in immersion mode freezing. INP emission factors will also be determined for all three species. These laboratory results will be incorporated into a regional modeling framework to explore the potential for SPPs and pollen grains to influence health and cloud formation.

6BA.5

Influence of Weather Conditions on Size-resolved Bioaerosols near Livestock Farms. NOHHYEON KWAK, Erin Cortus, Carol Cardona, Kristelle Mendoza, Veronica Tonnell, Jiayu Li, *University of Minnesota*

Livestock production is one source of bioaerosol particles. Livestock farms vary in physical size, animal density, and management practices, which can affect bioaerosol concentration. These bioaerosols can serve as vectors for pathogens, leading to emerging health concerns for farm workers and residents in the vicinity. Although pathogen-loaded bioaerosols have been detected in several studies, the transmission pathway is still unclear. Therefore, it is critical to reveal through what activities bioaerosols are generated and dispersed; in conjunction with bioaerosol qualification, this helps quantify the risk for disease spread. Thus, in this study, we investigated the impact of meteorological events (windy, calm, and rain) on bioaerosol generation and dispersion. The change in bioaerosol concentration and diversity were characterized before and after these scenarios. This study characterized the physical and biological size-resolved aerosols at a livestock farm (1 m away from the barn) and urban background. Bioaerosols were collected by three sampling instruments (SPOT sampler, SKC Biosampler, and Sioutas impactor). An optical particle counter (OPC) and scanning mobility particle sizer (SMPS) characterized aerosol physical properties (size distribution). The mass concentration of total suspended particles (TSP) and PM_{10} in the livestock farm (16.9±13.5 and 10.6 ±7.3 µg m^{-3}, respectively) is higher than in the urban background (9.2±5.3 and 8.2±4.4 µg m^{-3}). The $PM_{2.5}$ and PM_1 on the livestock farm (3.7±1.5 and 2.3±1.2 µg m^{-3}) are lower than in the urban background (6.0±3.7 and 5.1±3.5 µg m^{-3}). From preliminary qPCR results, farm samples and background samples have similar microbial content in size range from 2.5 µm to 1 µm, while farm samples showed a significantly higher microbial concentration in particles larger than 2.5 µm or less than 1 µm. This investigation can reveal the concentration and diversity differences of aerosol and bioaerosol particles in the urban background and around the barns.

6BA.6

Bioaerosol Sources and Sinks in Northern Alaska: a Microbiome Study. MARINA NIETO-CABALLERO, Jessie Creamean, Thomas C. J. Hill, Kevin R. Barry, Christina S. McCluskey, Thomas A. Douglas, Paul DeMott, Sonia Kreidenweis, *Colorado State University*

As a result of Arctic air temperatures rising at more than twice the global rate, permafrost and ice wedges are rapidly thawing, releasing greenhouse gas reservoirs, and microorganisms with greenhouse gas-generating metabolism. Thawed permafrost landslides are also increasing due to warming temperatures, introducing thawed soil into a range of water bodies (i.e., ocean, rivers, and lakes). Microorganisms from thawed permafrost and ice wedges discharged to these water bodies can ultimately be aerosolized through wind-driven and/or greenhouse gas bubble bursting in thermokarst lakes. In addition, these airborne biological particles can be a potential source of biologically-derived ice nucleating particles (INPs) at warm temperatures (≥ -10ºC), potentially altering cloud dynamics in Arctic regions.

In this study, we present data from environmental samples collected during Summer 2021 in Northern Alaska (Utqiaġvik region), including air, water (i.e., ocean, rivers, and thermokarst lakes), permafrost, ice wedge, and vegetation samples, as well as aerosol particle distribution data. Here, we present results processed for 16S rRNA gene sequencing to identify and classify microorganisms, showing for the first time how microorganisms in permafrost, ice wedges, vegetation, and different water bodies are potential sources and sinks of bioaerosols in Northern Alaska, based on amplicon DNA analysis. The obtained air microbiome results are additionally linked to air mass back trajectories calculated with NOAA's HYSPLIT model. This study is part of the multidisciplinary ARCSPIN project (ARCtic Study of Permafrost Ice Nucleation), which additionally includes INP analysis, as well as aerosol and INP modeling.

6BA.7

Molecular Changes in Bacteria after Aerosolization Leading to Antimicrobial Resistance. BROOKE SMITH, Maria King, *Texas A&M University*

The study of environmental changes triggering antimicrobial resistance (AMR) expression is a growing field, but not much has been studied on how aerosolization effects and triggers AMR. This should be of particular interest for high resistance reservoirs such as hospitals and meat-producing facilities. The goal of this research is to uncover how Gram-negative bacteria respond to aerosolization at a molecular level using the laboratory strain *Escherichia coli (E. coli)* MG 1655 as surrogate bacterium. Fresh mid-log phase bacterial suspensions were aerosolized for 5 different time durations into a sterile airtight chamber and collected using a bioaerosol collector. Each sample was analyzed based on its response to aerosolization by molecular analysis such as specific antibiotic resistance gene (ARG) expression, genetic sequencing, antibiotic susceptibility testing and molecular dynamics simulations. Strong resistance and binding to efflux pump active sites was detected to cell wall and protein synthesis inhibitors after aerosolization. Resistance to the highest number of antibiotics was detected in the shortest aerosolization samples while exposure for longer aerosolization durations caused an increased amount of stress which bacteria could not alleviate, indicating the involvement of different mechanisms to respond to short-term and long-term exposures. There were also clear phenotypic changes in E. coli cells particularly at the cell membrane. This study aims to demonstrate that aerosolization triggers antimicrobial resistance and show the changes linked to mechanisms of resistance, especially efflux pump regulation, in E. coli.

6BA.8

Single Viable Bioaerosol Particle Discerning Using Naked Eye Assisted with Laser Trapping and Microwaving. XINYUE LI, Maosheng Yao, *Peking University*

Viable microbial aerosol detection remains a grant challenge. Instruments replying on laser-induced florescence often produce false positives as chemicals also emit similar florescence when irradiated. Here, we pioneered a new system that integrates laser trapping and microwave irradiation for online discerning of single viable microbial aerosol particle through naked eye. To test the system, three fungal species Aspergillus niger, Aspergillus oryzae, and Trichoderma harzianum and three non-biological particles such as MnO2, active carbon, and Fe3O4 were suspended and laser trapped in the air inside a house-made glass cube. When microwave irradiated, viable fungal spores, containing microwave energy absorbing molecules such as water, were observed to rapidly escape the trapping and even burst with abrupt morphology changes for a longer irradiation time. In contrast, those non-biological particles were observed to behave differently with little morphology change without the cell burst. For all particles tested, microwave irradiation resulted in particle movement within the trapping region, and a particle trapping was then re-established in a new location. Depending on particle type and irradiation time, light scattering properties also differ between biological and non-biological particles when irradiated. Terminating the microwave irradiation was observed to render the non-biological particles to return where they are being laser trapped. Using the developed system, we have demonstrated the viable microbial aerosol detection using naked eye by simply observing the morphology changes and cell burst upon the laser trapping and microwave irradiation. Further efforts on this development could lead to a new generation of bioaerosol detection strategy.

6CC.1

Water Uptake of Monoterpene Aerosol Mixtures: Towards a Central Value. Bret Hatzinger, Ziheng Zeng, Tim Raymond, DABRINA DUTCHER, *Bucknell University*

Understanding secondary organic aerosol (SOA) properties is essential in understanding cloud formation, which represents a significant uncertainty in the context of global climate modeling. Monoterpenes are a class of semi-volatile organic compounds (SVOCs) of both biogenic and anthropogenic origins, emitted into the atmosphere. These compounds, when oxidized, contribute to the formation of SOA. It has been found that half of all total fine organic aerosol can be attributed to monoterpene oxidation. The resultant aerosol particles may also act as cloud condensation nuclei and contribute to cloud growth. Understanding the water uptake ability, or hygroscopicity, of these compounds improves our knowledge of their radiative effects, which can be used to improve climate models. Given that the SOA terpene precursors rarely occur in the atmosphere in isolation, an understanding of their group hygroscopicity will prove at least as valuable as any measurements with single species precursors. To this end, the hygroscopcity of aerosols created from the oxidation of 12 different monoterpenes was measured using a cloud condensation nuclei counter (CCNC) and scanning mobility particle sizer. A single parameter hygroscopicity (κ) value for the aerosol products from each compound was determined and then the compounds were combined in various mixtures. A span of mixture types, from similar (high/high) to contrasting (high/low) in value were analyzed. While not every possible combination was chosen for experimentation, mixtures were intentionally selected so as to provide a wide base of meaningful data. Preliminary results show that as more SOA precursors are introduced into the reaction mixture, κ values trend towards a central value, approximately 0.14.

6CC.2

The Hygroscopicity of Functionalized Insoluble Aerosol Surfaces. CHUN-NING MAO, Kanishk Gohil, Akua Asa-Awuku, *University of Maryland*

Insoluble particles can provide a surface for water molecules and can act as cloud condensation nuclei(CCN) under supersaturated conditions. The water-uptake process (hygroscopicity) depends on the bulk chemistry of the nuclei and the chemical and physical surface properties. However, the impact of molecular surface chemistry for CCN activity has remained elusive; the porous structure and the non-sphericity of particles have made aerosol measurement and CCN prediction challenging. To understand the role of the surface chemistry in the water uptake, we study the CCN activity of non-porous, spherical polystyrene latex (PSL) particles with (PSL-NH_2 and PSL-COOH) and without (plain PSL) surface modification. Three thermodynamic models, traditional Köhler theory, the Flory-Huggins Köhler theory and the Frenkel-Halsey-Hill adsorption theory (FHH-AT) predict the activation behavior. Among all, the Frenkel-Halsey-Hill adsorption theory, with two parametrizations, A_{FHH} and B_{FHH}, is the only model capable of agreeing with measurement and predicting the slight differences between the different molecular level functions on PSL surfaces. PSL-NH_2 has the highest CCN activity, while the plain type PSL shows the lowest. The B_{FHH} parameter represents the interaction between the bulk nuclei and the water molecules and when B_{FHH} is constrained to unity, the A_{FHH} for PSL-NH_2, PSL-COOH and plain PSL is 0.23, 0.21, and 0.18 respectively. The results of the constrained fit imply that the CCN activity of the functionalized surface correlates to the polarity of functionalized groups. Lastly, we develop a single parameter hygroscopicity representation for insoluble aerosol derived from principles of the FHH-AT model. We demonstrate that the hygroscopicity based on FHH-AT model can predict the decreasing trend with the dry particle size of insoluble particles.

6CC.3

Effects of Mixing State on Water-Uptake Properties of Binary Mixtures. Patricia Razafindrambinina, Kotiba A. Malek, Kristin DiMonte, Joseph Dawson, TIM RAYMOND, Dabrina Dutcher, Miriam Freedman, Akua Asa-Awuku, *University of Maryland*

Aerosol particles in the atmosphere have the ability to uptake water and form droplets. The droplets formed can interact with solar radiation and influence the net radiative forcing. However, the magnitude of change in radiative forcing due to the indirect effect of aerosols remains uncertain due to the high variance in aerosol composition and mixing states, both spatial and temporally. As such, there is a need to measure the water-uptake of different aerosol particle groups under controlled conditions to gain insight into the water-uptake of complex ambient systems. In this work, the water-uptake (hygroscopicity) of internally and externally mixed ammonium sulfate – organic binary mixtures were directly measured via three methods and compared to droplet growth prediction models.

We found that subsaturated water-uptake of ammonium sulfate-organic mixtures agreed with their supersaturated hygroscopicities, and mixing state information was able to be retrieved at both humidity regimes. In addition, we found that solubility-adjusted models may not be able to capture the water-uptake of viscous particles, and for soluble organic aerosol particles, bulk solubility may not be comparable to their solubility in a droplet. This work highlights the importance of using multiple complementary water-uptake measurement instruments to get a clearer picture of mixed aerosol particle hygroscopicity, especially for increasingly complex systems.

6CC.4

Quantifying Activation of Aerosol Particles with LES-driven Parcel Simulations. LAURA FIERCE, Jesse Andersen, Will Cantrell, Jerome Fast, Claudio Mazzoleni, Mikhail Ovchinnikov, Raymond Shaw, Fan Yang, *Pacific Northwest National Laboratory*

Droplet activation and growth by aerosol particles is an important process governing aerosol-cloud interactions, but modeling the evolution of complex particle populations within a cloud's turbulent environment is computationally difficult. Modeling studies of cloud condensation nuclei activity by complex aerosol populations have typically relied on idealized parcel simulations in which all particles experience the same environmental properties; turbulence-induced fluctuations in environmental properties are ignored. Here we present a new framework for modeling the evolution of complex particle populations within turbulent clouds. We used high-resolution Large Eddy Simulations of the turbulent environment in the Pi Chamber, a convective cloud chamber at Michigan Technological University, to drive particle-resovled simulations of aerosol-cloud interactions along Lagrangian trajectories within the chamber. The air parcels were initialized with particles sampled from populations simulated by the particle-resovled aerosol model, PartMC-MOSAIC. We show that droplet activation and growth is strongly enhanced by turbulent fluctuations in water vapor and temperature, which indicates that sub-grid heterogeneity in environmental properties must be well represented in models to accurately predict aerosol interactions clouds.

6CC.5

Size-Resolved Aerosol Composition over the Arctic Reveals Cloud Processed Aerosol In-Cloud and above Cloud. NURUN NAHAR LATA, Zezhen Cheng, Darielle Dexheimer, Fan Mei, Swarup China, *Pacific Northwest National Laboratory*

Aerosol physicochemical properties have a significant impact on Arctic climate via both aerosol-radiation and aerosol-cloud interactions. Several previous ground-based aerosol measurements indicate the relevance of aerosol composition for Arctic cloud formation. However, the morphology and chemical composition of the aerosols from ground-based measurement might be different from those of the particles at high altitudes due to oxidation and cloud processing, which is poorly understood due to limited observation of size-resolved aerosol chemistry in the cloud. This study investigated the vertical variability of aerosol particle composition in August 2019 using a tethered balloon system (TBS) at the US Department of Energy's Atmospheric Radiation Measurement Program's mobile facility at Oliktok Point, Alaska. This study focused on different cloud layers under two typical conditions, background aerosol and polluted conditions. A total of ~19600 particles from two case studies were characterized using single-particle multimodal micro-spectroscopy techniques. The chemical analysis shows a clear difference in vertical aerosol chemical compositions. The background case indicates a broadening of chemically specific size distribution with a high abundance of sulfate aerosols at the high altitude (1000m, which was above the cloud) with core-shell morphology, suggesting possible cloud processing of particles. The low altitude (500m, in the cloud) aerosol is dominated by carbonaceous aerosol with narrow size distribution. The pollution case also indicates a broadening of size distribution at high altitude (1125m, which was in the cloud) with the dominance of carbonaceous and sulfate coated aerosol particles, whereas the low altitude (725m) particle population is richer in carbonaceous, carbonaceous coated dust particles with narrow size distribution. The broadened carbonaceous aerosol population from high altitude can serve as cloud condensation nuclei and participate in Arctic cloud formation. Findings from this study will improve the understanding of the implication of Arctic aerosol physicochemical properties on Arctic cloud formation and radiative properties.

6CC.6

Quantification of Vanadium in Non-Refractory Marine Boundary Layer Particles: Impacts of Heavy Fuel Ships on Particulate Matter (PM) in the Remote Central Pacific. MAYA ABOU-GHANEM, Daniel Murphy, Gregory Schill, Michael Lawler, *National Oceanic and Atmospheric Administration*

The world economy is highly dependent on the shipping industry, which is responsible for approximately 90% of global trade. To date, most ships rely on the combustion of heavy fuel oils, which contain metals, including vanadium and nickel. It is well established within the atmospheric research community that vanadium can serve as a tracer for particulate matter (PM) generated by heavy fuel ship exhaust. Previous studies have suggested that PM from ships may have climate implications due to vanadium's ability to catalyze the aqueous-phase oxidation of SO_2 to sulfate and sulfuric acid, which are important aerosol components for cloud formation.

To better understand the climate implications of vanadium in the marine atmosphere, Particle Analysis by Laser Mass Spectrometry (PALMS) was deployed on the NASA DC-8 aircraft for real-time individual aerosol particle analysis during the 2016–2018 Atmospheric Tomography Mission (ATom). Using preliminary PALMS data sets obtained during ATom, we observe vanadium in ~2% of accumulation mode particles measured in the remote central Pacific and find that most of these vanadium-rich particles reside in the lower troposphere. Interestingly, these measurements were taken in the absence of ship plumes, which means that PM from ships may remain in the atmosphere for extended periods of time; however, to fully understand the global distribution of PM from ship emissions, PALMS calibrations are required. Here, I present PALMS laboratory calibrations of mixed vanadium, sulfate, and organic aerosol particles, which I use as a proxy for PM from ship exhaust, to quantify vanadium-containing particles measured during ATom. This work will further our understanding of both the chemical composition and the distribution of PM from ship plumes, leading to new insights into the cloud formation properties of these particles.

6CC.7

Significant Spatial Gradients in New Particle Formation Frequency in Greece during Summer.

ANDREAS AKTYPIS, David Patoulias, Christos Kaltsonoudis, Angeliki Matrali, Christina Vasilakopoulou, Nikolaos Mihalopoulos, Panagiotis Kalkavouras, Aikaterini Bougiatioti, Nikos Kalivitis, Konstantinos Eleftheriadis, Stergios Vratolis, Maria Gini, Athanassios Kouras, Mihalis Lazaridis, Sofia-Eirini Chatoutsidou, Athanasios Nenes, Spyros Pandis, *University of Patras, Greece*

Homogeneous nucleation is an important source of new particles in the atmosphere. The resulting newly formed stable nuclei can grow to larger sizes and affect air and climate. Unexpected significant spatial variability of the nucleation frequency has been observed in Greece in the only previous study; high frequency in Thessaloniki, intermediate in Eastern Crete and low in Patras (Patoulias et al., 2018). Our hypothesis is that Greece may be an excellent natural laboratory to investigate the factors affecting nucleation and to understand the reasons behind this surprising variability.

Extensive continuous aerosol size distribution measurements took place during two summers (2020 and 2021) in the frame of the PANACEA project in 11 different locations all over Greece. The instrumentation used included several scanning mobility particle sizers (SMPS) and a suite of gas (SO_2, NOx, NH_3 and CO) monitors. A particle size magnifier (PSM) was deployed in Patras during the 2021 campaign providing valuable information regarding nanoparticles with diameter down to 1 nm.

The observations suggest that indeed the nucleation frequency during summer in Greece varies from close to zero in the southwestern part of the country to more than 80% in the northern central and eastern regions. The detailed analysis of the measurements in Patras suggests that nucleation was infrequent in this location, but particles that were formed a few hours earlier over central Greece are often transported to this area after they have grown to sizes of 20-30 nm. Analysis of the backward air trajectories arriving in Patras was performed to locate the areas in which new particles are formed. The corresponding measurements in Patras were also used to estimate the corresponding particle growth rates. The analysis of the measurements in the various sites shows that the proximity to coal-fired power plants is a major factor affecting the nucleation frequency.

6CC.8

Southern Ocean (50°S-68°S, 63°E-150°E) Boundary Layer CCN-active Aerosols Latitudinal and Seasonal Distribution during the MARCUS.

QING NIU, Greg McFarquhar, Connor Flynn, *University of Oklahoma*

The Southern Ocean (SO), for its remoteness, providing a natural laboratory to study aerosol-clouds interactions in varying meteorological conditions. The Atmospheric Radiation Measurement Program's Mobile Facility-2 onboard the Australian icebreaker Aurora Australis obtained ship-based cloud, precipitation, and aerosol measurements during the 2017-18 Measurement of Aerosols, Radiation, and CloUds over the SO (MARCUS) Experiment during cruises across the SO. After the analysis of meteorological regimes, the SO has been divided into NSO (50°S-60°S) and SSO (62°S-68°S).

The negative Aerosol Scattering Angstrom Exponent (AE) curvature indicates the aerosol size distribution in both NSO and SSO are monomodal and dominated by the fine mode aerosols with diameter $D < 250$ nm. However, histogram of Condensation Nuclei (CN) shows high fine mode aerosols events ($CN > 1000\ cm^{-3}$) is significantly more frequent in SSO ($P<0.05$), with limited seasonal variation. This may be related to more frequent new particle formation events over the SSO. The AE at wavelengths 450, 550, and 700 nm measured by the Nephelometer show AE modes (α) of 0.5 ($\alpha_{450-550}$) and 0.8 ($\alpha_{450-700}$) in NSO, and of 1.1 ($\alpha_{450-550}$) and 1.4 ($\alpha_{450-700}$) in SSO. This implies aerosols have higher effective radii in NSO. The latitude dependence of Cloud Condensation Nuclei-active aerosols, approximated by the concentrations of aerosols with diameter $60\ nm < D < 1000\ nm$ measured by the Ultra-High-Sensitivity Aerosol Spectrometer (UHSAS), hereafter $N_{60-1000nm}$ (similar notation below), is examined by latitude and season because of their potential influence on cloud microphysical properties. $N_{60-1000nm}$ shows larger seasonal variation in SSO than NSO. Besides, the NSO $N_{500-1000nm}$ is 41% larger and aerosol concentrations for $60\ nm < D < 200\ nm$, $N_{60-200nm}$, 32% less, and $N_{CCN,0.2}$ ($N_{CCN,0.5}$) is 60 cm^{-3} (79 cm^{-3}) less compared to the SSO.

Further, aerosol hygroscopicity Growth Factor (GF) measured by the Hygroscopic Tandem Differential Mobility Analyzer (HTDMA) stayed close to 1.4 for $N_{60-1000nm}$ with $D < 250$ nm in SSO, but with mode changes from 1.3 to 1.67 in NSO as D increases. This implies the chemical compositions of aerosols with $50\ nm < D < 250\ nm$ are relatively uniform in SSO, while in NSO the composition changes with aerosol size (e.g., aerosols with $D \sim 50$ nm and $GF \sim 1.3$ might be organic aerosols or non-neutralised sulphuric acid, while the larger hygroscopicity variability for aerosols in NSO might be driven by inorganic salts composition). The modality of aerosols size distribtuion ($60\ nm < D < 250\ nm$) shifts when non-precipitating low clouds cloud-base-height decreases, consistent with clouds acting as sources.

6IA.1

Simulated Epidermal Formation of Tobacco-Specific Nitrosamines (TSNAs) from the Nitrosation of Nicotine with Atmospheric HONO.

XIAOCHEN TANG, Peyton Jacob III, Christopher Havel, Marion Russell, Neal Benowitz, Lara Gundel, Hugo Destaillats, *Lawrence Berkeley National Laboratory*

Tobacco-specific nitrosamines (TSNAs) are emitted during smoking, and can be produced in the indoor environment after smoking has ended. Among them, N'-nitrosonornicotine (NNN) and 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK) are human carcinogens with no significant risk levels (NSRLs) of 500 and 14 ng day^{-1}, respectively. 4-(methylnitrosamino)-4-(3-pyridyl) butanal (NNA), shows genotoxic and mutagenic activity in vitro. Because of the presence of nicotine on thirdhand smoke (THS)-laden indoor surfaces and human skin, and the emissions of HONO from combustion sources of indoor and outdoor origin, TSNAs are expected to be formed continuously in indoor environments impacted by smoking.

We investigated the effects of skin constituents on the reaction of adsorbed nicotine with HONO on different model substrates. Individual specimens containing a known surface concentration of nicotine were placed inside a flow chamber and exposed to HONO-enriched air (500 ppb, 50% RH) for 1 hour. The fraction of consumed HONO was determined by ion chromatography. Extracts of the exposed specimens were analyzed by LC-MS/MS to quantify TSNAs, and by GC/MS for the remaining nicotine. Higher TSNA concentrations (0.3 – 3.7 ng cm^{-2}) were formed on cellulose and cotton substrates coated with human skin oils and sweat, with respect to clean substrates. In all extracts, NNA levels were highest, while NNK was present at higher concentration than NNN. These results were combined with reported air, dust and surface concentrations to assess potential NNK daily intakes. Three different dermal uptake pathways (by direct contact, air-to-skin deposition and epidermal nitrosation of nicotine) were predicted to exceed the NSRL in realistic scenarios, contributing significantly to total NNK intake at comparable levels as inhalation. Results illustrated that exposure to NNK via multiple pathways could increase cancer risk for adult non-smokers exposed to THS indoors.

6IA.2

Measurements of Indoor Ammonia and Amines With a Chemical Ionization Mass Spectrometer.

LEE TISZENKEL, Shanhu Lee, *University of Alabama Huntsville*

The effect of ammonia and amines on outdoor atmospheric air quality is well documented. These gases can impact human health through direct exposure as well as their tendency to react with precursors such as sulfuric, nitric or hydrochloric acids to form particulate matter. Ammonia and amines are ubiquitous in indoor environments due to the human body's constant emission of these compounds through the skin and breath. There exists a great deal of ambient outdoor measurements of ammonia and amines, but indoor measurements of these chemicals are very scarce. Consequently, concentrations of ammonia and amines in homes or workplaces are largely unknown. In this study we present measurements of ammonia and amines containing up to 6 carbon atoms conducted in a laboratory environment using a chemical ionization mass spectrometer (CIMS) with an ethanol ion reagent. Detection limits of the instrument to ammonia and amines are in the single-digit ppt range. Air velocity and turnover was measured with a TSI air velocity meter. Measurements with the CIMS were conducted continuously for weekend days with no human presence, regular work days with one or two individuals working near the instrument, as well during a three-day workshop conducted in the lab with up to seven people present. Concentrations of ammonia were measured from sub-ppb levels to tens of ppb during high levels of human activity. Amines ranged from below detection limits to tens of ppt. The data presented here further elucidate a critical aspect of indoor air quality that remains unknown due to the difficulty of its measurement.

6IA.3

Secondary Organic Aerosol Formation from Cl-Initiated Oxidation of Limonene under Indoor and Outdoor Lighting Conditions. PEARL ABUE, Pawel K. Misztal, Lea Hildebrandt Ruiz, *The University of Texas at Austin*

Limonene is an abundant volatile organic compound (VOC) outdoors and indoors. Oxidation of limonene by the hydroxyl radical (OH), nitrate radical (NO_3), and ozone have been studied. However, the role of chlorine (Cl) radical in the oxidation of limonene in indoor and outdoor environments has not received much attention. High concentrations of limonene and Cl_2 have been observed in indoor environments (10s of ppb of limonene and up to 100 ppb of Cl_2 after terpene and bleach cleaning, respectively). Here, we present results from environmental chamber experiments on Cl-initiated oxidation of limonene under varied lighting, NOx, relative humidity (RH), and temperature conditions. In addition to typical UV blacklights used for radical generation, the impact of LED lights in the visible spectrum typical of indoor lighting conditions was explored. Under UV lighting, organic aerosol mass yields from these experiments are around 1, exceeding recorded yields from OH and NO_3 oxidation of limonene. We observe the formation of oxidation products driven by simulated indoor lighting conditions (LED). We also measure early generation products in the gas phase from hydrogen abstraction like $C_{10}H_{15}O_2$ and products of chlorine addition like $C_{10}H_{16}ClO_2$. These experiments provide evidence for indoor oxidative chemistry that may contribute to indoor SOA or subsequent SOA formation following transport outside the home.

We utilize an Aerosol Chemical Speciation Monitor (ACSM), Scanning Electrical Mobility System (SEMS), Proton Transfer Reaction Mass Spectrometer (Vocus-2R-PTRMS), and an iodide mode, filter inlet mounted on a High-Resolution Time of Flight Chemical Ionization Mass Spectrometer (I- FIGAERO-CIMS) to measure gas and particle-phase products and record multiple highly oxygenated molecules in both phases.

6IA.4

Modeling Transformations in Indoor Inorganic Aerosol Composition and Concentrations When Passing through an HVAC System with ISORROPIA. BRYAN BERMAN, Bryan Cummings, Xinxiu Tian, Peter F. DeCarlo, Shannon Capps, Michael Waring, *Drexel University*

Aerosol constituents are transformed as they are transported through ventilation systems into buildings. For instance, changes in temperature and relative humidity (RH) between indoors and outdoors influence the partitioning of specific aerosol components. Previously, IMAGES (Indoor Model of Aerosols, Gases, Emissions, and Surfaces), a modeling platform that simulates indoor organic aerosol, was extended to incorporate the inorganic aerosol (IA) thermodynamic equilibrium model, called ISORROPIA. ISORROPIA estimates partitioning of inorganic aerosols and precursor gases. The model was previously applied to simulate indoor IA in a classroom during the summer and winter with measurements from Avery et al. (2019). However, the model was limited because impacts from the heating, ventilating, and air conditioning (HVAC) system were not included. Modeling inorganic aerosols through the HVAC system will allow a deeper understanding of the influence of large temperature and RH gradients across heating and cooling coils, which influence aerosol partitioning. Additionally, gases such as ammonia and nitric acid can be lost with condensate water, and particles may be lost to the filter, cooling coil, and heating coil. An HVAC module was developed to address this gap. The model was evaluated against measurements of PM_1, $PM_{2.5}$, and PM_{10}, temperature and RH from multiple locations in the HVAC system of a building at Johns Hopkins University during select periods of winter and summer of 2021. This module will be incorporated into the IMAGES framework to better simulate indoor IA of outdoor origin.

6IA.5

Reactive Oxygen Species on Indoor Surfaces.

ZHENDUO YAO, Glenn Morrison, Ryan Moravec, *UNC-Chapel Hill*

Reactive Oxygen Species (ROS) are relatively unstable oxygen-containing radicals or non-radicals, some of which may react with tissues and biomolecules after entering human body. ROS is present on indoor aerosols but it is unclear how much is of indoor origin. As a potentially important source of ROS generation, indoor surfaces are now known to be coated with unsaturated hydrocarbons that can react with ozone and other oxidants. In this study, the ROS concentration on several indoor surfaces was measured using a xylenol orange ferrous oxidation assay after wiping and extraction. The preliminary results show that, on surfaces frequently touched by occupants, the concentration is about 0.2 nmol/cm^2; this is two to three times greater than surface not frequently touched. In addition, kitchen surfaces exposed to cooking fumes contain even higher concentrations of peroxide, with some exceeding 0.5 nmol/cm^2. Based on this observation, we studied the development of ROS in laboratory experiments. To simulate the oxidation of unsaturated hydrocarbons on indoor surfaces, a soybean oil-acetone solution was dosed on 22 identical glass plates. The acetone evaporates almost immediately leaving a thin oil film. The ROS concentrations were measured daily. During the first 5-6 days, the ROS concentration increased roughly linearly. After this, the concentration on the glass surface tends to be stabilize, perhaps reflecting a balance between formation and decay of ROS.

6IA.6

Predicting Floor-Based Variability in Composition and Concentration of Indoor Aerosol of Outdoor Origin in a High-Rise Multi-Family Building.

XINXIU TIAN, Bryan Cummings, Michael Waring, Marianne Touchie, Peter F. DeCarlo, *Johns Hopkins University*

In this work, we model how the differences in building ventilation rates by floor and variation in outdoor aerosol concentration and composition impact indoor aerosol within a high-rise multi-family building. In the absence of strong indoor sources, outdoor-originated aerosols are the main contributor to indoor aerosols. Upon transport to the indoor environment, both concentrations and chemical compositions of outdoor aerosols are modified. Many studies show the linkage of indoor concentrations of ambient $PM_{2.5}$ to various factors, including infiltration, ventilation rates, deposition and filtration, and phase change of semi-volatile material during outdoor-to-indoor transport. We demonstrate that inconsistent airflow patterns caused by natural and mechanical ventilation within a single building can induce differences in indoor concentrations of outdoor $PM_{2.5}$. Airflow and pollutant simulations were performed with a CONTAM building model to obtain the indoor-outdoor ratio of a non-volatile, non-reactive test species under different ambient temperatures. Chemical compositions of ambient $PM_{2.5}$ were reconstructed from regulatory monitoring data based on modified $PM_{2.5}$ mass reconstruction techniques. Outdoor PM concentration and composition were used to calculate indoor-outdoor ratios of semi-volatile species including NO_3, HOA, and OOA using linear relationships developed by previous modeling work. Indoor-outdoor ratios and, by extension, concentrations and composition of particulate chemical species showed variation across seasons and by floor due to non-uniform building ventilation air distribution. This work demonstrates that there are significant temperature-based and floor-based variations in indoor-outdoor ratios of chemical species within a single building, with variations in chemical compositions of ambient $PM_{2.5}$, resulting in strong seasonal and floor-based variations in indoor concentrations and compositions of ambient species.

6IA.7

Dynamics of Particle- and Gas-Phase Total Water-Soluble Organic Carbon at the CASA Indoor Air Study.

MARC WEBB, Glenn Morrison, Naomi Chang, Karsten Baumann, Marina Vance, Delphine K. Farmer, Dustin Poppendieck, Barbara Turpin, *University of North Carolina at Chapel Hill*

Previous time-integrated (2-4 hour) measurements have demonstrated that total gas phase water soluble organic carbon (WSOCg) is 10-20 times higher inside homes compared to outside. However, the sources, sinks, reservoirs, and dynamics of gas phase (WSOCg) and particle phase WSOC (WSOCp) in indoor air are not well understood, and to our knowledge, WSOC species mass closure has not been attempted. As part of the recent CASA indoor air study, a total carbon analyzer alternated every 6 min between a particle-into-liquid sampler (PILS) and mist chamber (MCs) to capture the real-time (4 s resolution) dynamics of WSOCg and WSOCp in the unfurnished, unoccupied National Institute of Standards and Technology Net Zero Energy Test House during a variety of scripted activities. The low WSOC background with windows open and high WSOC background with windows closed suggests that building materials comprise a major source of WSOC. WSOCg was generally 3-4x higher than WSOCp. Scripted indoor cooking and cleaning (except for cooking with vinegar) were minor contributors, whereas the introduction of smog precursors (acetone, toluene-d8, o-xylene, chlorobenzene, 2-pentanone, 2-heptanone, alpha-Pinene, 1-hexene, isoprene, 1-octene, furfural) and simulated wildfire smoke significantly increased indoor WSOC concentrations. Surprisingly, ozone additions did not induce a measurable increase in WSOC. WSOCg and WSOCp decay rates were 0.90 and 0.94 hr-1, respectively, with window opening; when windows were subsequently closed concentrations rebounded, presumably as a result of WSOC release from indoor reservoirs. The effects of activities, indoor conditions, ventilation and air cleaners and insights concerning indoor WSOC reservoirs will be discussed.

6IA.8

Profiles of Neutral, Volatile Per- and Polyfluoroalkyl Substances (PFAS) in Residential Indoor Air and Particle Samples From the Indoor PFAS Assessment Campaign.

CLARA EICHLER, Naomi Chang, Elaine Cohen Hubal, Jiaqi Zhou, Jason Surratt, Glenn Morrison, Barbara Turpin, *UNC-Chapel Hill*

Per- and polyfluoroalkyl substances (PFAS) comprise >9,000 chemicals with a wide range of physicochemical properties. Many PFAS are used in building materials and consumer products, and thus, pose a potential exposure risk. However, PFAS levels and partitioning in indoor environments are not well understood. As part of UNC’s Indoor PFAS Assessment (IPA) Campaign, we measured PFAS in indoor air in 10 homes in North Carolina using PUF-XAD-PUF sandwich cartridges (72 h sampling duration, 5 L/min sampling flow rate), with and without an upstream quartz fiber filter (QFF). Total air (unfiltered) and gas-phase only (pre-filtered) samples were collected in each home at the beginning of the field campaign, and after 3 and 6 months. Samples were extracted and analyzed for eight neutral, volatile PFAS using gas chromatography/electron ionization-mass spectrometry (GC/EI-MS). The sum of neutral PFAS in total air samples ranged from 3-52 ng/m^3. Concentration profiles varied strongly between and within homes, reflecting the dynamic nature of PFAS in indoor air. Most consistently, 6:2 and 8:2 fluorotelomer alcohol (FTOH) were found in all samples, accounting for 70-95% of measured neutral PFAS. Results for total air and gas-phase only samples were usually similar, indicating that neutral PFAS species are predominantly in the gas phase in indoor air. However, higher particle concentrations indoors were associated with larger differences between total air and gas-phase only samples. Analyses of QFFs placed upstream will be used to further assess the presence of neutral PFAS in airborne particles in homes. This will allow discussion of the dependence of PFAS profiles and partitioning on physicochemical properties, particle concentrations, and other factors.

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6IM.1

Understanding the Source Components Captured by the Purple Air Network. VIJAY KUMAR, Dinushani Senarathna, Supraja Gurajala, William Olsen, Shantanu Sur, Sumona Mondal, Suresh Dhaniyala, *Clarkson University*

PM2.5 has been linked to numerous pollution-mediated adverse health effects and their monitoring is key for taking preventative and mitigative measures. Accurate measurements of PM2.5 concentrations are available at EPA sites, but such data lacks spatial resolution due to a limited number of monitoring locations. In recent years the deployment of low-cost sensor networks has opened up the possibility of acquiring air quality data at a high spatiotemporal resolution. However, the sensitivity, noise, and accuracy of data acquired by low-cost sensors remain a concern. Here, we studied PM2.5 measurements made from EPA and Purple Air (PA) sensor networks in the Chicago area to understand the parameters influencing the performance characteristics of the low-cost sensor network. We decomposed the PM2.5 time series data into short-term, seasonal, and long-term components using the Kolmogorov–Zurbenko (KZ) filter. We then extracted different frequency signals of PM2.5 data for each of the filtered components. The PA sensor data accurately capture long-term variations in the PM2.5 data but not short-term variations (<24 hours). We hypothesize that the sensor networks may have different sensitivity to aerosol from different sources and hence care must be taken in their use for evaluating the impact of air quality mitigation policies. Therefore, calibrations should be performed in short-term, seasonal, and long-term components of PM2.5 measurements captured by low-cost sensors using reference monitors before using them into epidemiological studies.

6IM.2

Portable, Low-cost Samplers for Distributed Sampling of Aerosols and Reactive Gases. JAMES HURLEY, Alejandra Caceres, Ksenia Onufrieva, Gabriel Isaacman-VanWertz, *Virginia Tech*

At present, field measurements of gas- and particle-phase reactive organic compounds are often performed using large, expensive, sophisticated instrumentation such as mass spectrometers. Such instrumentation is logistically challenging to deploy and requires skilled operators for maintenance and analysis. Alternatively, filter- and/or adsorbent-based sampling approaches allow offline collection and are comparatively simple. However, collection of samples requires significant operator effort and most available samplers are insufficiently portable, cheap, and/or flexible to enable distributed sampling across spatial or temporal scales. For example, existing tools generally lack the ability to synchronize the timing of multiple samples, may not monitor and/or control sample flow to provide identical sampling conditions, and may not be weatherproof and solar powered for long-term outdoor deployment. We present and validate here a network of distributed samplers for addressing a range of scientific questions regarding the spatial and temporal distributions of reactive organic compounds and aerosol precursors. Over a dozen low-cost (~$500 in materials) samplers have been built and validated in laboratory and field studies. Air is sampled at a known and controlled flow rate through a filter cartridge that can be used for particle sampling or, in the case of gas sampling, removal of oxidants using a sodium thiosulfate impregnated filter. Gases are sampled downstream of the filter on an adsorbent cartridge for subsequent analysis by gas chromatography-mass spectrometry (GC-MS). Utility and validation of the samplers is demonstrated by their deployment to: (a) locate sources of reactive gases by mobile sampling across a spatial domain, (b) measure vertical gradients of aerosol precursors through contemporaneous synchronized sampling at multiple heights, (c) measure trends in atmospheric composition through long-term intermittent deployment, and (d) particle sampling at multiple outdoor sites simultaneously. Improvements to increase flow rates and enhance usability for particle sampling will be discussed.

6IM.3

Precision and Accuracy of PM2.5 Monitors: Impacts on Air Sensor Evaluations. KAROLINE BARKJOHN, Andrea Clements, Amara Holder, Robert Vanderpool, Brett Gantt, Tim Hanley, *US Environmental Protection Agency*

$PM_{2.5}$ sensors are typically collocated with conventional air monitors to better understand their performance. These monitors may include filter based federal reference methods (FRM), federal equivalent methods (FEM), temporary smoke monitors, research-grade methods, or other near-FEM technology. This work evaluates the strengths and limitations of these comparison methods and the implications for correctly interpreting sensor evaluation results. This work uses PurpleAir PA-II sensors collocated with a variety of monitors across the U.S. to explore the influence of comparison monitor type on perceived sensor performance. In addition, the bias of FEM Teledyne API T640 and T640x optical PM monitors has been evaluated to understand when these monitors are most suitable for sensor comparisons. The Teledyne T640 and T640x have become popular FEM choices in the past few years and provide precise measurements relative to FRMs at low concentrations. This work analyzes 3 years of collocated T640 and FRM data from across the U.S. to understand T640 and T640x bias compared to the FRM. Piecewise regression was used to understand nonlinearity at higher concentration. Findings suggest that FEM T640 and T640x data may have a nonlinear relationship with FRM concentrations above ~35 $\mu g/m^3$. Understanding the strengths and limitations of monitors is crucial when using them to evaluate air sensors.

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6IM.4

Performance of Plantower PMS Sensors and the Alphasense Optical Particle Counter for Measuring PM10 Concentration in the Laboratory and Field. KERRY KELLY, Kamaljeet Kaur, Ross Whitaker, *University of Utah*

Regulatory measurements of PM_{10} (particulate matter, PM, smaller than 10 µm in diameter) are even sparser than regulatory measurements of $PM_{2.5}$ (PM smaller 2.5 µm in diameter). Although low-cost sensors could supplement regulatory monitors, most of these sensors are not effective at measuring PM_{10} in spite of claims by sensor manufacturers. Elevated PM_{10} concentrations can be important sources of PM pollution, particularly in arid regions of the US. The Salt Lake Valley is one area that faces such challenges. Climate change and receding levels of the Great Salt Lake have led to more than 750 mi^2 of exposed playa, and appropriate meteorological conditions cause dust events with elevated PM_{10} concentrations, sometimes reaching 400 $\mu g/m^3$. More highly resolved measurements of PM_{10} would permit a better understanding of potential health risks and to identify hotspots. This study evaluated the laboratory and field performance of three versions of the Plantower PMS (3003, 5003, and 6003) and the Alphasense OPC-N3. Our preliminary results suggest that the PMS sensors severely underestimated PM10 concentration (~ factor of 10) compared to FEM measurements during a two month period that included four dust events. They also exhibited relatively poor correlation with FEM PM10 measurements (R^2 ~ 0.3 – 0.5). The OPC-N3 detected all the four dust events (slope of ~ 0.9) and exhibited better correlation with FEM PM_{10} measurements (R^2 ~ 0.7) during this same period. In the laboratory, the study evaluated sensor performance and intra-sensor variability using a flow-focusing monodisperse aerosol generator and aerodynamic particle sizer. Overall, the Alphasense N3 OPCs appeared to be capable of measuring PM_{10}. It may be possible to combine a limited number of Alphasense OPC N3s with the widely distributed networks of PurpleAir and AirU sensors (Plantower PMS) to improve the spatial and temporal estimates of PM_{10} concentration.

6IM.5

Mobile Monitoring of PM2.5 - Insights from On-road Comparisons with MetOne BAM 1020 and Teledyne T640 FEMs. ANDREW WHITEHILL, Melissa Lunden, Brian LaFranchi, Paul Solomon, Surender Kaushik, *United States Environmental Protection Agency*

Spatially and temporally resolved fine particulate matter ($PM_{2.5}$) measurements can provide insight into population exposure to $PM_{2.5}$ in different communities and neighborhoods, including in environmental justice regions. Aclima, Inc. has performed ongoing mobile monitoring in the San Francisco Bay Area of California for over 3 years, including measuring size-binned particle number counts in the 0.3 µm to 2.5 µm diameter range using an optical particle counter (OPC). During this period, there have been periods of driving with or near various continuous $PM_{2.5}$ federal equivalent methods (FEMs), including MetOne BAM 1020 and Teledyne T640 monitors. We demonstrate comparisons between OPC estimates of $PM_{2.5}$ and continuous FEM measurements of $PM_{2.5}$ in both low (background) and high (wildfire-impacted) regimes. The OPC had stronger correlations with the Teledyne T640, especially in lower concentration regimes, than with the BAM 1020. However, correlations between the OPC and BAM 1020 improved during wildfire events with higher $PM_{2.5}$ loading. The high limit of detection (and higher noise) for the BAM 1020 versus the Teledyne T640 makes comparisons with the T640 easier for calibrating lower-cost sensors and mid-range PM monitors at typical ambient $PM_{2.5}$ concentrations. We will conclude with a case study demonstrating preliminary results of mobile $PM_{2.5}$ measurements using OPCs in the San Francisco area.

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6IM.6

Performance of Nephelometric and OPC-based Lower-Cost Monitors in Dusty and Desert-Influenced Environments. R. SUBRAMANIAN, Mohammed Ayoub, Shamjad Moosakutty, Rami Alfarra, *Qatar Environment & Energy Research Institute*

Air pollution is the largest environmental health risk, with an estimated toll of almost 7 million deaths in 2019 (HEI State of Global Air). Fine particulate matter mass ($PM_{2.5}$) is a key contributing pollutant. In rapidly growing middle-eastern cities, PM_{10} from natural and anthropogenic sources is also critical. QEERI operates a network of six reference-grade stations across Greater Doha including three that monitor PM_{10}, but micro-environments such as traffic, industrial activity, and construction can result in hyperlocal pollution not captured by these reference stations. Lower-cost sensors can fill this data gap, enabling high spatial and temporal resolution measurements of air pollution. We have conducted extensive field testing of a variety of lower-cost devices for PM measurements across Doha. We find that sensor design can fatally compromise product performance for super-micron aerosol, with implications for accurate monitoring of both $PM_{2.5}$ and PM_{10}. Nephelometric PM sensors (e.g. Plantower-based) significantly underestimate $PM_{2.5}$ mass during dust events and are poorly correlated with reference beta attenuation monitors. Sensors using optical particle counters (OPC only or hybrid nephelometric/OPC sensors) perform relatively better but need to be properly field-characterized. As seen elsewhere, aerosol hygroscopic growth can also impact sensor performance. Well-characterized sensors have been effectively used to detect the impact of hyperlocal air pollution, e.g. from construction dust piles. We shall discuss these results and their implications for air quality monitoring in Qatar and similar regions especially around major athletic events.

6IM.7

Personal Exposure using Low Cost PM Sensors in Low Income Denver Communities. MARYAM ANIYA KHALILI, Nicholas Clements, Sophie Dolores Castillo, Dulce Gonzalez-Beltran, Allison Heckman, Tim Herwig, Marisa Westbrook, Valentina Serrano-Salomon, Omar Hammad, Esther Sullivan, Shivakant Mishra, Shelly L. Miller, *University of Colorado Boulder*

The Social Justice and Environmental Quality (SJEQ) – Denver project funded by National Science Foundation is working in the communities of Globeville, Elyria-Swansea, Cole, and Clayton in Denver, Colorado to understand and improve the disruption from the major construction going on in the area. Community members use personal low cost PM sensors (Atmotubes) to monitor their exposure to air pollution as they go about their day. During our first Cohort more than 50 participants from the communities joined our project and used the Atmotube sensors for an entire month. We finished Cohort one on March 4th 2022. We also successfully deployed five QuantAQ sensors outdoors in the community for the whole cohort time period.

Our second cohort is starting May 20th 2022 and ends on June 20th 2022. In this presentation we will describe our initial analysis of these exposure data. We correct our data using measurements from calibration colocation experiments. Finally we will study these air quality data looking for trends and information about air quality exposure (PM1, PM2.5) within the community.

6IM.8

An Automated Size and Time-resolved Aerosol Collector (STAC) and Integrated Sensors for Atmospheric Studies. ZEZHEN CHENG, Andrey Liyu, Darielle Dexheimer, Nurun Nahar Lata, Casey Michael Longbottom, Gourihar Kulkarni, Fan Mei, Swarup China, *Pacific Northwest National Laboratory*

Ambient aerosols affect human health, visibility, and climate. However, our understanding of these effects of aerosols is still limited, and part of that is because of the limited knowledge of the size-dependence of aerosols properties and variation of these properties along with the vertical profile under different environmental conditions. Therefore, we present a lightweight automated Size and Time-resolved Aerosol Collector (STAC), which has been deployed on the Atmospheric Radiation Measurement (ARM) tethered balloon system (TBS) in several ARM campaigns in Alaska and Southern Great Plains. The battery-powered STAC comprises a pump (5 lpm), latched solenoid valves, a single-board computer and circuit board to control valves, and a touch screen display to program the sampling. The STAC is integrated with temperature, pressure, relative humidity, and altitude sensors along with a portable optical particle spectrometer (POPS) and a condensation particle counter (CPC) to measure the aerosol size distribution and a mini- aethalometer to measure black carbon mass concentration every second. The STAC is loaded with an array of 4-stage cascade impactors to investigate the dependence of aerosol properties on ambient conditions. Experimentally derived 50% cut off size at 3 lpm of each stage (stage A to D) for a standard impactor are 5 µm, 2.5 µm, 0.42 µm, and 0.12 µm. The impactor is adaptable to collect smaller size particles with an additional Stage E with a 50% cutoff size of 0.07 µm. At each stage, we can load three substrates to collect ambient aerosols for multi-modal analysis to probe their physical (e.g., phase state and morphology), chemical (e.g., the elemental composition of individual particles and size-resolved chemical composition), and optical (light absorption and scattering) properties. The data ensemble from the various deployment provides the vertical profile of aerosol chemical composition and can aid the multi-phase chemistry and ice nucleation study.

6PC.1 (Invited)

Molecular Drivers of Nascent and Aged Marine Aerosol Phase States. JONATHAN SLADE, Paul Tumminello, Samantha Kruse, Karen Lopo Zepeda, *University of California San Diego*

The world's oceans serve as a major reservoir of organic carbon and inorganic salts, which can become airborne in sea spray aerosol (SSA), constituting the greatest mass flux of aerosol globally. The phase state (viscosity) of SSA and the evolution of SSA phase state due to atmospheric aging are not well known but aerosol viscosity can affect atmospheric composition and the aerosol's ability to serve as cloud condensation and ice nuclei. Here, nascent SSA was generated in a wave flume mesocosm during a controlled phytoplankton bloom. We employed a particle bounce apparatus and used extractive electrospray ionization mass spectrometry to measure modulations in the phase state and molecular composition of the aerosol in real time. The observed particle bounce fractions indicate that nascent SSA is more viscous during peak biological activity with estimated viscosities of the organic material of up to 10^3-10^4 Pa·s at the peak of biological activity, compared to <10^2 Pa·s during periods of low biological activity. These differences are attributed to differences in the molecular weights and hygroscopicity of the organic material in SSA dependent upon the stage of the bloom. The nascent SSA was further aged in an oxidative flow reactor by hydroxyl radicals (OH) between the equivalent of 5 and >21 days of atmospheric exposure at $[\mathrm{OH}]=1.5\times10^6$ molecules cm^{-3} in the presence of marine volatile compounds. At low levels of OH exposure, the particle bounce fraction increased with aging, whereas extensive aging led to less viscous phase states. To better constrain the role of heterogeneous OH oxidation on the phase state of SSA, laboratory mimics of SSA composed of mixtures of fatty acids and inorganic salts (NaCl and $CaCl_2$) were aged in an oxidation flow reactor under varying OH exposures between 0 and 5 days equivalent aging in the atmosphere. In the absence of OH, divalent Ca^{2+} in the SSA mimic promoted stronger intermolecular interactions with marine-relevant fatty acids and more viscous particles compared to mixtures composed of monovalent Na+. Oxidative aging of pure fatty acid organic aerosol by OH decomposed and volatilized the organic material leading to a reduction in particle volume of 80%, whereas the presence of NaCl under the same OH exposures decreased particle volume by up to 20%. Particle bounce fractions increased with increasing OH exposure for the pure fatty acid aerosol, whereas mixtures with NaCl led to no change, suggesting that major decomposition products such as aldehydes in the aerosol phase may condense in the more acidic particle environment with lower levels of inorganic salts, promoting more viscous, bouncier particles with aging. These results have important implications for SSA lifetimes and potentially processes such as ice nucleation in the marine atmospheric environment.

6PC.2

Vertical Gradient of Aerosol Phase State over Stratified Alaskan-Arctic. NURUN NAHAR LATA, Zezhen Cheng, Susan Mathai, Darielle Dexheimer, Fan Mei, Swarup China, *Pacific Northwest National Laboratory*

Particles' phase state has a tremendous impact on several atmospheric processes such as heterogeneous reaction, cloud formation, heterogeneous ice nucleation, and secondary aerosol formation, which affects the Earth's climate. The particles' phase is governed by the characteristics of the particles (e.g., chemical composition) and atmospheric conditions (e.g., temperature and relative humidity). Due to the spatial and temporal variation of atmospheric conditions, ambient particles can exist in different phase states (e.g., liquid, semi-solid or solid). Additionally, the Arctic atmosphere is stratified, with different aerosol chemical compositions at different layers. However, our knowledge about the vertical profile of phase states is still not sufficient due to the lack of observation. It is essential to study the vertical profile of the phase state of submicron size ambient particles to understand the atmospheric processes over the Arctic.

The aerosol sampling was conducted via the tethered balloon system (TBS) at the U.S. Department of Energy Atmospheric Radiation Measurement Program's facility at Oliktok Point, Alaska, to probe the vertical profile of the aerosol phase state. The TBS was loaded with an automated Size and Time-resolved Aerosol Collector (STAC) to collect particles at different altitudes for offline chemical analysis. The collected particles were characterized by using multimodal micro-spectroscopy techniques such as computer-controlled scanning electron microscopy with energy-dispersive X-ray spectroscopy scanning transmission X-ray microscopy with near-edge X-ray absorption fine structure spectroscopy. The chemical analysis indicates high altitude particles are dominated by carbonaceous particles and dust whereas low altitude particles are richer in carbonaceous and sulfate. We will probe the phase state of the ambient particles using an Environmental Scanning Electron Microscope (ESEM) with a tilted Peltier stage at atmospheric relevant temperature and relative humidity. Combining the chemical composition and direct observation of the phase state will improve our understanding of the vertical profile of the phase state.

6PC.3

Surfactant Properties Influence Hygroscopic Growth of Submicron and Supermicron Model Sea Salt Particles.

AMANDA FROSSARD, Rachel Bramblett, Ben Swanson, *University of Georgia*

The size and composition of atmospheric aerosol particles modulate their interactions with solar radiation, and thus their influence on climate and visibility. The radiative effects of aerosol particles remain a large uncertainty in accurately modeling and predicting current and future climates. Sea spray aerosol particles are a significant fraction of particle mass and number in the atmosphere, and their size and composition influence their radiative properties and cloud condensation nuclei activity. Hygroscopic growth of these particles is dependent on their size and the hygroscopicity of the sea salt and organic fractions. Recent work has demonstrated the presence of organic surfactant molecules in sea spray aerosol particles, in both submicron and supermicron size regimes. The role of the chemical and interfacial properties of surfactants and their overall influence on the hygroscopic growth of aerosol particles is still unknown. Here, we demonstrate the influence of surfactants with different properties on the hygroscopic growth and deliquescence of model inorganic salt aerosol particles. We compare the hygroscopic growth of individual, supermicron particles measured with an aerosol optical trap to that of a distribution of submicron aerosol particles measured with a humidified tandem differential mobility analyzer. The properties of surfactants within individual, supermicron aqueous NaCl particles, including molecular size, structure, and ionicity, determine their effect on NaCl particle hygroscopic growth. Supermicron particles containing both NaCl and large, nonionic surfactants showed an increase in hygroscopic growth from that of pure aqueous NaCl particles by up to 3%. However, this deviation was not observed in aqueous NaCl particles containing anionic or cationic surfactants, suggesting different electrostatic interactions between the different surfactants and NaCl ions in solution. This work demonstrates that the charge of the surfactant polar head group controls the influence on particle hygroscopic growth for supermicron particles, due in part to interactions with the salt ions. For the submicron particle sizes, the presence of surfactants alters the growth factors of sea salt aerosol particles differently at humidities above and below the sea salt deliquescence relative humidity. In this study, the addition of ionic surfactants increased sea salt hygroscopic growth factors by up to 4% at 60% relative humidity but decreased growth factors by up to 6% at 85% relative humidity. Additionally, the presence of ionic surfactants in submicron sea salt particles decreased their characteristic deliquescence relative humidity. The changes in sea salt particle hygroscopic growth varied for the different surfactants studied demonstrating the influence of individual surfactant properties, most notably ionicity, on particle hygroscopic growth.

6PC.4

Solid Organic-coated Ammonium Sulfate Particles at High Relative Humidity in the Summertime Arctic Atmosphere.

ANDREW AULT, Rachel Kirpes, Ziying Lei, Matthew Fraund, Matthew Gunsch, Nathaniel May, Tate Barrett, Claire Moffett, Andrew Schauer, Becky Alexander, Lucia Upchurch, Swarup China, Patricia Quinn, Ryan Moffet, Alexander Laskin, Rebecca J. Sheesley, Kerri Pratt, *University of Michigan*

The ability of atmospheric aerosols to impact climate through water uptake and cloud formation is fundamentally determined by the size, composition, and phase (liquid, semisolid, or solid) of individual particles. Particle phase is dependent on atmospheric conditions (relative humidity and temperature) and chemical composition and, importantly, solid particles can inhibit the uptake of water and other trace gases, even under humid conditions. Particles composed primarily of ammonium sulfate are presumed to be liquid at the relative humidities (67 to 98%) and temperatures (22 to 4°C) of the summertime Arctic. Under these atmospheric conditions, we report the observation of solid organic-coated ammonium sulfate particles representing 30% of particles, by number, in a key size range (<0.2 µm) for cloud activation within marine air masses from the Arctic Ocean at Utqiagvik, AK. The composition and size of the observed particles are consistent with recent Arctic modeling and observational results showing new particle formation and growth from dimethylsulfide oxidation to form sulfuric acid, reaction with ammonia, and condensation of marine biogenic sulfate and highly oxygenated organic molecules. Aqueous sulfate particles typically undergo efflorescence and solidify at relative humidities of less than 34%. Therefore, the observed solid phase is hypothesized to occur from contact efflorescence during collision of a newly formed Aitken mode sulfate particle with an organic-coated ammonium sulfate particle. With declining sea ice in the warming Arctic, this particle source is expected to increase with increasing open water and marine biogenic emissions.

6PC.5

Phase, Morphology, and Water Uptake Measurements of Mixed Salt Nano-Nuclei Found in Kidney Stones. DEWANSH RASTOGI, Kanishk Gohil, Kotiba A. Malek, Chao Peng, Mingjin Tang, Akua Asa-Awuku, *University of Maryland College Park*

Kidney stone formation is attributed to the deposition of various salts or minerals inside the renal gland. Current treatments rely on invasive techniques that involve chemo dissolution or surgery. The solute-solvent interaction plays a significant role in kidney stone formation. Hence, investigating this property on a nanoscale can help with prevention and improved treatment methods.

In this work, the water uptake of aerosolized uric acid, calcium oxalate, calcium phosphate, and ammonium magnesium phosphate, and a mixture of these salts is investigated under sub- and supersaturated conditions using H-TDMA and CCNC measurements. In addition, the water uptake was also investigated for bulk salts using a Thermogravimetric Analyzer (TGA). Our water uptake measurements show that uric acid particles have a very low hygroscopicity value (less than 0.01) than inorganic salts such as sodium chloride. Due to the low solubility of salts, an adsorption model was used to obtain an accurate water uptake profile for each of the salt and mixtures. The hygroscopicity values differed at subsaturated and supersaturated conditions for droplet dried particles. Bulk salt particles were found to have a lower affinity for water than submicron particles. This indicates the salt particles crystallize from surrounding media even at low concentrations in the solution phase. Once formed, these crystals tend to be difficult to dissolve.

Furthermore, the morphology of particles at submicron sizes is significantly different from super micron size crystalline particles. Visualization tools such as electron microscopy reveal that mixed salt nuclei can result in homogeneous and phase-separated particles. This suggests heterogeneous nucleation can occur at the initial stages of nucleation and eventually stone formation. The phase of mixed salt nanoparticles also affects the water uptake properties of particles.

6PC.6

Impacts of Non-ideal Mixing and Phase State on Equilibration Timescales of Secondary Organic Aerosol Partitioning. MEREDITH SCHERVISH, Manabu Shiraiwa, *University of California, Irvine*

Experimental analysis and numerical modeling that probe equilibration timescales of secondary organic aerosol partitioning usually employs an ideal mixing assumption in the particle phase. Here we apply the kinetic multilayer model of gas-particle partitioning (KM-GAP) to simulate SOA partitioning into a core-shell phase-separated particle. By varying key parameters of a condensing gas-phase species including activity coefficient and bulk diffusivity, we probe the complex interplay of mass transfer kinetics and thermodynamics of partitioning. We found that non-ideality can impact SOA partitioning kinetics: a higher activity coefficient of the condensing species in the shell leads to the transport of species to the core being limited by the total amount of species the shell can hold, whereas a lower activity coefficient will require higher amounts of species to reach equilibrium being limited by gas-particle mass transfer. In addition, we notice that the particle may achieve quasi-equilibrium with the gas phase long before it achieves full equilibrium of the entire particle bulk with low activity coefficient of species in the shell in a semi-solid or amorphous solid state. These results provide useful insights into analysis and interpretation of SOA partitioning experiments as well as description and treatment of SOA in aerosol models.

6PC.7

Effects of Organic Water on Inorganic Aerosol Thermodynamics.

Stylianos Kakavas, Athanasios Nenes, SPYROS PANDIS, *University of Patras*

In this work we present the effects of secondary organic aerosol water (SOAW) on inorganic aerosol thermodynamics. Organic aerosol although less hygroscopic than inorganic, could also contribute significantly to the total atmospheric aerosol water levels (Guo et al., 2015). The added water mass can induce secondary inorganic aerosol formation since more of the gas phase components partition to the aerosol to satisfy equilibrium (e.g., Ansari and Pandis, 2000). These feedbacks are usually not considered in chemical transport models simulations.

For that purpose, we use a new developed inorganic aerosol thermodynamics module, ISORROPIA-lite (Kakavas et al., 2022), an accelerated and simplified version of the widely used ISORROPIA-II (Fountoukis and Nenes, 2007), which considers secondary organic aerosol water to thermodynamic equilibrium and assumes that the aerosol is in metastable equilibrium (aerosol exists only in liquid form) using binary activity coefficients from precalculated tables. We used ISORROPIA-lite in PMCAMx chemical transport model simulations over Europe and continental United States to study organic aerosol water effects.

Simulations considering the effects of secondary organic aerosol water show average increases of the concentrations of the inorganic semivolatile components and especially that of nitrate within 0.25 μg m^{-3} over continental Europe and US. However, the temporal evolution shows that except organic water could highly contribute to the total PM_1 water mass, can also increase the concentrations of fine nitrate and ammonium within 1.5 μg m^{-3} in places where secondary organic aerosol and RH levels are high.

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6PC.8

A Step-wise Hydration Model of Organics and Electrolytes.

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

Atmospheric aerosol particles may contain an aqueous phase and one or more organic or solid phases. The aqueous phase solute concentrations are usually high since the water activity is governed by the ambient relative humidity. In many situations, the solute may supersaturate leading to concentrations beyond the available data. At high concentrations, the transport properties of the aerosol particles also change reducing diffusivity within the particle. These high concentrations challenge current aerosol thermodynamics modelling approaches. Here we present a simple step-wise hydration modelling paradigm for modelling the activity of organic and electrolyte solutes and water as the solvent at high concentration while also predicting the amount of water bound to the solutes and the amount that is free.

7AC.1

Struvite-Catalyzed Photochemical Reactions of Aqueous-Phase Guaiacyl Acetone and 3,4-Dimethoxybenzaldehyde.

MARIA MISOVICH, Manoj Silva, Robert Blakeslee, Jonas Baltrusaitis, Alexander Laskin, *Purdue University*

Struvite ($NH_4MgPO_4 \bullet 6H_2O$) is a water insoluble mineral nanocrystal frequently found in fertilizers that can be transported to airborne particles by raindrop-induced aerosolization from agricultural soils exposed to irrigation and rain events. Guaiacyl acetone (GA, $C_{10}H_{12}O_3$), a prominent product of biomass burning emissions, partitions rapidly into the aqueous phase, suggesting that it is a relevant proxy compound to represent organic species in aqueous-phase atmospheric aerosol. When irradiated in the presence of triplet excited carbon ($^3C^*$), GA has been found to undergo rapid oxidation reactions to form monomeric and dimeric brown carbon products. This study investigates the effect of struvite on the photoreactions of aqueous GA in the presence of 3,4-dimethoxybenzaldehyde (DMB, $C_9H_{10}O_3$), a source of $^3C^*$ frequently found in biomass burning emissions. A solar simulator was used to mimic sunlight. GA and DMB were irradiated with and without struvite, and samples of the resulting reaction mixtures were collected at 0, 20, 60, and 120 minutes. Chemical components of the mixtures were analyzed using reversed phase liquid chromatography interfaced with a photodiode array detector and an ESI-HRMS Orbitrap mass analyzer. Our results indicate that introducing struvite into the system accelerates the formation of major chromophore products and catalyzes the formation of several minor unique chromophores not found in the struvite-free system. Struvite serves as a heterogenous catalyst, and it is also suspected to generate OH radicals in water. Top down mass absorption coefficient (MAC) plots indicate that total absorbance decreases with irradiation in all three systems, but that the rate is impacted by the presence of struvite. Mass spectra show that the products initially fall into classes of monomers and dimers, but that products outside of these classes formed after longer irradiation times. Elemental formulas were assigned for all prominent chromophores. Tentative structures and a mechanism were proposed and discussed.

7AC.2

Phase Morphology and Optical Properties of Brown Carbon Containing Aerosol Particles.

Chelsea Price, JAMES F. DAVIES, Thomas Preston, Roya Bahreini, *University of California Riverside*

Wildfires and biomass burning are a significant source of brown carbon (BrC) chromophores to aerosol particles into the atmosphere. These chromophores absorb light leading to atmospheric warming with a magnitude estimated to be equal an opposite to the cooling effect of scattering particles. Of particular interest are nitrated aromatic compounds because of their strong absorptive properties, formation during daytime and nighttime reactions, and water solubility. Due to their water solubility, BrC particles may act as cloud condensation nuclei and knowledge of their humidity-dependence physical and optical properties will be important to better understand their role in the atmosphere.

In this work, a linear quadrupole electrodynamic balance with a broadband light source was used to illuminate levitated aqueous brown carbon particles consisting of 4-nitrocatechol (4NC) for Mie resonance spectroscopy. The back scattered light from the particle was then used to determine the size, refractive index, and dispersion properties simultaneously. We measured the hygroscopic growth and optical properties of pure 4NC particles as well as mixtures of 4NC containing a non-absorbing inorganic component (ammonium sulfate) over a range of mixing ratios. (Price et al., Environ. Sci. Technol. 2022, 56, 7, 3941–3951). We identified the phase transitions in the mixed particles noting the onset of liquid-liquid phase separation and efflorescence. Going forwards, we will use these established methods as a basis to explore the behavior of other nitroaromatic compounds, such as 4-nitrophenol and 4-nitrobenzoic acid, as well as chamber generated BrC-SOA.

7AC.3

Evaporation of Volatile Components Transforms Optical Properties and Composition of Aged BrC Aerosol. DIEGO CALDERON-ARRIETA, Ana Morales, Anusha P.S. Hettiyadura, Chunlin Li, Taylor Estock, Yinon Rudich, Alexander Laskin, *Purdue University*

Atmospheric brown carbon (BrC) summarizes a matrix of atmospheric organic aerosol components with varying light absorbing properties that influence air quality and climate forcing. BrC can be secondarily generated from transformations of anthropogenic emissions and directly emitted from biomass burning (BB). Once released, BB-BrC transforms rapidly via interactions with other air pollutants and solar irradiation. Current climate models cannot adequately assess warming effects of BrC because of large uncertainty in the light absorption properties inherent to the highly variable composition of BrC and its dynamic atmospheric aging. Our previous study has found that the atmospheric pressure (0.5-1.0 atm) determined gas-particle partitioning (evaporation) of volatile chromophores can shift light absorption of BB-BrC from very-weakly to moderately absorbing. To better understand the relationship between light absorption and volatility of BB-BrC species, and also to probe fractions of BB-BrC chromophores of varying volatility, we investigated effects of thermal-evaporation processes on the BB-BrC optical properties. Lab generated BrC materials from wood pyrolysis were conditioned at ~350 ^oC for different time periods with protection of inert gas. Based on comprehensive analysis via high performance liquid chromatography, optical spectroscopy, and high-resolution mass spectrometry, it was found that evaporation of volatile components of BrC is an important factor in enhancing BB-BrC light absorption. For the first time, this study distinguishes fractions of BB-BrC with different volatility and light absorption characteristics, which inform predictive understanding of BrC transformations and associated climate-health effects in the atmosphere.

7AC.4

Heterogeneous Chemistry on Biomass Burning Aerosol: Aircraft Measurements of N2O5 and ClNO2 during FIREX-AQ. Zachary Decker, STEVEN S. BROWN, Kenneth Aikin, Ilann Bourgeios, Pedro Campuzano-Jost, Matthew Coggon, Josh DiGangi, Glenn Diskin, Frank Flocke, Alessandro Franchin, Carley D. Fredrickson, Georgios Gkatzelis, Hongyu Guo, Sam Hall, Hannah Halliday, Katherine L. Hayden, Christopher D. Holmes, Jose-Luis Jimenez, Melinda Beaver, Ann M. Middlebrook, D. D. Montzka, Richard Moore, J. Andrew Neuman, John Nowak, et al., *National Oceanic and Atmospheric Administration*

Biomass burning (BB) emissions contain large amounts of both reactive nitrogen (NO, NO_2, HONO) and particulate chloride (pCl^-). Oxidation of reactive nitrogen species by ozone produces dinitrogen pentoxide, N_2O_5, which reacts heterogeneously to form soluble nitrate and gas-phase nitryl chloride, $ClNO_2$. Subsequent photolysis releases atomic chlorine and recycles NO_2. Here, we analyze in situ aircraft measurements of aerosol composition, surface area, N_2O_5, $ClNO_2$, nitrogen oxides and ozone in BB plumes sampled during the 2019 FIREX-AQ campaign and report the first aircraft observations of N_2O_5 and $ClNO_2$ in fire plumes.

The NASA DC-8 and NOAA Twin Otter sampled wildfire plumes across the western U.S., and the DC-8 further sampled agricultural emissions in the southeast U.S. Normalized excess mixing ratios (NEMRs) of pCl^- were consistent with laboratory derived emission factors for different fuel types and were larger in agricultural fire plumes. Plume enhancements of N_2O_5 and $ClNO_2$ were routinely observed from the DC-8 during daytime flights and from the Twin Otter on targeted night flights, with up to 340 pptv of $ClNO_2$ at night. We present comparisons of an observationally constrained Lagrangian box model determination of the N_2O_5 uptake coefficient, $\gamma(N_2O_5)$, and $ClNO_2$ yield, $\phi(ClNO_2)$, to parameterizations based on aerosol composition and calculated liquid water content.

Box model determinations of $\gamma(N_2O_5)$ were consistently below the range of values reported from laboratory studies ($\gamma < 10^{-3}$). Parameterized $\phi(ClNO_2)$ from pCl^- and liquid water had median values of 0.82 and 0.87 for wildfire and agricultural fire smoke, respectively, while the box model for six wildfire plumes showed lower values, consistent with previous work and laboratory determinations. These results have implications for the total budget of tropospheric halogen activation through biomass burning emissions and chemistry, as well as for ozone loss induced by heterogeneous reactions following injections from large wildfire plumes to the stratosphere.

7AC.5

Secondary Organic Bulk and Molecular Aerosol Yields and Product Identification and Quantification using HPLC technique from the OH and NO3 initiated Photooxidation of 5 BBVOCs. MELINDA SCHUENEMAN, Douglas Day, Demetrios Pagonis, Pedro Campuzano-Jost, Seonsik Yun, Olivia Jenks, Dongwook Kim, Marla DeVault, Paul Ziemann, Joost de Gouw, Jose-Luis Jimenez, *CIRES, University of Colorado, Boulder*

Wildfires are increasing in frequency and intensity in recent years due to an expanding population, increased land clearing for agriculture, and climate change. Wildfires emit a wide array of gas- and particle-phase species into the atmosphere, therein leading to complex physical and chemical composition of species present in wildfire smoke. This complexity can not always be explained with ambient atmospheric measurements alone, leading to a need to understand individual or mixed wildfire components in a simplified system. Chamber experiments were conducted for five known biomass burning (BB) -emitted volatile organic compounds (VOCs): phenol, catechol, styrene, furfural, and methyl furfural. For these experiments, multiple particle-phase instruments (EESI-HR-ToF, HR-AMS-ToF, SMPS) and gas-phase instruments were operated (Vocus-ToF and Iodide CIMS). Each VOC was reacted with either the hydroxyl (OH in a high NOx environment) or nitrate (NO3) radical. The former involves a series of "lights on" steps, where OH is formed and reacted with the existing VOC and oxidation products, forming SOA. SOA yields were quantified for all five VOCs, and SOA yield curves were fitted to a VBS. Matching literature observations, phenolic compounds like catechol and phenol had high SOA yields across multiple C* bins. The lesser-studied species furfural, styrene, and methyl furfural also had substantial SOA formation potential. Molecular yields were also found for the more abundant products in each system where direct or indirect calibrations could be performed. Indirect calibrations involved a coupling of the HPLC technique with the EESI and AMS, where we separated individual particle components (extracted from a filter) by their solubility and polarity. Individual species are then re-aerosolized and measured with the EESI and AMS.

7AC.6

Effects of Humidity on Secondary Organic Aerosol Formation from Furanoid Oxidation with Hydroxyl Radicals. TAEKYU JOO, Jean Rivera-Rios, Tori Hass-Mitchell, Jo Machesky, Drew Gentner, Matthew Alvarado, Nga Lee Ng, *Georgia Institute of Technology*

Biomass burning emits substantial amounts of non-methane organic compounds (NMOCs) that can contribute to the formation of secondary organic aerosol (SOA). Recent studies suggest that a large fraction of SOA can be produced from non-traditional precursors, including furanoids, that are highly reactive with common atmospheric oxidants. Here, we investigate SOA formation from photooxidation of furfural, 2-methylfuran, and 3-methylfuran in the Georgia Tech Environmental Chamber (GTEC) facility. Experiments are performed under dry (RH<5%) and humidified (RH 50 – 60%) conditions with ammonium sulfate seed aerosols in the presence of NO_x. For all precursors, SOA yields are found to be higher under humid conditions. Across the three precursors, SOA yields and the resulting organic aerosol loadings (ΔM_o) from furfural were 6 – 10 times and 5 – 9 times higher, respectively, than that from 2-methylfuran and 3-methylfuran. For furfural, rapid SOA formation was observed under humid condition, whereas under dry conditions SOA was formed slowly and steadily until the end of the experiments. Both 2-methylfuran and 3-methylfuran experiments also show non-negligible SOA formation after the depletion of precursors under both RH conditions. We propose reaction mechanisms based on the compounds identified using a Filter Inlet for Gases and AEROsols coupled with a time-of-flight chemical ionization mass spectrometer (FIGAERO-HR-ToF-CIMS). The temporal evolution and thermograms of particle-phase species point to differences in oxidation and oligomerization mechanisms under different precursor and RH conditions. We find that fast uptake of furfural and first-generation products contribute to the rapid SOA formation rate under humid conditions in furfural experiments, and different peroxy radical branching pathways drive its higher SOA formation potential compared to methylfurans. These results contribute to our understanding of the oxidation of furans under different meteorological conditions and SOA formation in biomass burning plumes.

7CC.1

Ice nucleation of Organic and Inorganic Components of a Marine Coccolithophore (Emiliania huxleyi) and a Coccolithovirus. ALYSSA ALSANTE, Daniel Thornton, Sarah Brooks, Jessica Mirrielees, Elise Wilbourn, Brianna Hendrickson, Benjamin Diaz, Kay Bidle, *Texas A&M University*

In the marine environment, aerosol contains a significant amount of organic matter derived from phytoplankton production. A subset of aerosol catalyzes the freezing of atmospheric ice crystals by acting as ice nucleating particles (INPs) at temperatures above the homogeneous nucleation threshold (-38°C), significantly influencing tropospheric cloud formation. In this study, we investigated the ice nucleation of a globally distributed coccolithophore species, *Emiliania huxleyi*, before and after viral infection with a coccolithovirus (EhV-207) using a marine aerosol reference tank. Our results indicate the freezing temperature of calcifying *E. huxleyi* (-27.5 ± 1.5°C) was not statistically different than seawater (-29.0 ± 2.3°C) aerosolized in the MART. Viral infection with EhV-207 did not influence the freezing temperature (-28.4 ± 0.7°C). However, EhV-207 virus particles had a mean freezing temperature of -20.8 ± 1.6°C (10^5 viruses mL^{-1}) in the absence of *E. huxleyi*. To better understand why *E. huxleyi* is not an efficient INP, we investigated an uncalcified strain of *E. huxleyi*, purified coccoliths and dimethylsulfoniopropionate (DMSP). Uncalcified *E. huxleyi* froze at -30.2 ± 0.7°C, indicating the calcium carbonate covering of calcifying *E. huxleyi* has minimal impact on ice nucleation temperature. Purified coccoliths froze at a higher temperature (-25.3 ± 0.5°C) than either strain of *E. huxleyi*. The organo-sulfur compound dimethylsulfoniopropionate (DMSP) is produced by coccolithophores in high internal concentrations (>100 mM). DMSP has a median freezing temperature of -34.0 ± 1.5 °C, suggesting this compound could be responsible for depressing the freezing temperature of coccolithophores and sea-spray aerosol containing organic matter and DMSP. These findings suggest that there may be compounds within specific taxa of phytoplankton inhibiting ice nucleation and marine viruses are potentially an abundant source of INP to the atmosphere.

7CC.2

Detonation Soot as an Ice Nucleating Particle (INP). SETH THOMPSON, Sarah Brooks, *Texas A&M University*

Temperatures and pressures far exceeding typical atmospheric conditions arise from high explosive detonations, and by such means detonation soot forms with physiochemical properties unique from normal combustion. In nuclear war, high explosives within nuclear devices produce and loft detonation soot into the upper troposphere and stratosphere where it has potential to be an ice nucleating particle (INP). Due to the importance of INPs in ice cloud formation and subsequent climate impact, it is critical to investigate the ice nucleating ability of all possible aerosol, including unconventional aerosol like detonation soot. Samples of detonation soot from two high explosives, PBX 9502 and Composition B-3, were analyzed from both air and argon atmospheres. Contact and immersion mode nucleation temperatures were determined through a series of freezing experiments using 137 and 225 µm particles. Detonation soot samples nucleated ice on average at temperatures warmer than commercially available nanodiamond, which freezes at -20.7°C. A rapid 2-3 orders of magnitude increase in ice nucleation rate coefficients was observed beyond -20°C in every detonation soot sample, aligning with oxidized combustion soot. Detonation soot with 137 µm diameter from air atmosphere detonations produce bimodal freezing distributions with primary and secondary nucleation modes centered at -20 and -13°C, respectively. The warm secondary nucleation mode enables more efficient freezing with a rate coefficient increase of 1-2 orders of magnitude. Metal oxides may explain warm nucleation temperatures, and cuprous oxide was identified in 10% of detonation soot Raman spectra. Cuprous oxide froze on average at -21.1°C. A nuclear exchange, producing 180 Tg of soot, would substantially increase global INP populations. Primarily, detonation soot would impact mineral dust deprived regions. Additionally, a fraction of the detonation soot population nucleated at temperatures as high as -9.2°C, comparable to mineral dust, which suggests the possibility of global impacts on ice cloud formation.

7CC.3

Characteristics and Sources of Ice Nucleating Particles in the North-Western Himalayas. SHWETA YADAV, Nathaniel Curtis, Rebecca Venezia, Kiran Kumari, Sunandan Mahant, Ankit Tandon, Bruce Moffett, Ryan Paerl, Markus Petters, *Central University of Jammu, India*

The ice nucleating particles (INPs) in rainwater, aerosols and river water samples were measured using the Drop freezing assay. Three different campaigns were carried out in the North Western Himalayas to understand sources and characteristics of INPs. Heat treatment was applied to infer the presence of biological INPs. In the first campaign, time-resolved precipitation samples were collected in different seasons at Jammu (urban and rural) and urban locations in Dharamshala, Lucknow and New Delhi. Dominance of biologically active INPs and no influence of pollution on INP concentration was observed. In the second campaign, bioaerosol diversity and INP concentration in total suspended particulate matter were studied along a transect. The phyla *Firmicutes*, *Proteobacteria*, and *Actinobacteria* dominated the microbial community but Archaea were rare in aerosols. This work demonstrated the importance of surface sources, land use pattern, and local meteorology on the understanding of bioaerosols and their link with INP concentrations in the atmosphere. In the third campaign, water soluble ionic species using ion chromatography and INP concentrations were measured in surface water samples of three Himalayan rivers. This campaign showed that river water is a potential source of INPs in the Himalayas. The data reported here from the Himalayan region may help to constrain modelling studies that target aerosol-ice cloud interactions in this region.

7CC.4

Optical Characterization of Polluted Atmospheric Aerosols Generated in a Tabletop Chamber. CHRISTIAN PATTYN, Jake Zenker, Lekha Patel, Andres Sanchez, Andrew Glen, Brian Bentz, Jeremy Wright, *Sandia National Laboratories*

It is well understood that anthropogenic aerosols play an important role in our global climate, however, the effect of aerosols on cloud microphysical and optical properties is not fully understood. Further, atmospheric models are restricted in their ability to incorporate robust schemes needed to resolve the diffusion and hygroscopic growth of aerosols in a cloudy environment thereby limiting their ability to represent cloud optical properties. To better inform and verify these models, we’ve developed a tabletop fog chamber that can generate polluted clouds under an array of controlled conditions. The chamber is equipped with a suite of instruments that characterize the physical and optical properties of the generated clouds. Specifically, transmissivity is measured with a custom multiband transmissometer, providing transmission data in the visible, SWIR, and LWIR bands. Reflectivity is measured using a quartz-tungsten halogen lamp as the source, arranged coaxially behind a spectrometer, providing reflection data across a wide spectrum of wavelengths. We evaluated the optical properties of clouds generated with different temperatures and relative humidities relevant to the marine boundary layer using varying CCN compositions, concentrations, and sizes. We will discuss insights on the optical impacts of aerosol concentration can be applied to better represent cloud aerosol diffusion in atmospheric models.

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7CC.5

The OH Burst from Aerosols at the DOE Southern Great Plain ARM site. JIAQI SHEN, Catherine Banach, Suzanne E. Paulson, *University of California, Los Angeles*

OH-mediated cloud water chemistry has direct and indirect impacts on air quality and climate by modifying aerosol mass concentration, chemical speciation and size distributions. Studies have observed a fast OH formation phenomenon called OH burst in newly formed cloud droplets. In this study, we measured OH burst in newly formed cloud droplets using a direct-to-liquid spot sampler at the DOE Southern Great Plain ARM site during March and April, a period that typically experiences a contribution from both local biomass burning aerosols and biomass burning particles that have undergone long-term transport. We observe a wide range in the size of OH burst formation from aerosols collected on different dates, ranging from less than 100 nM up to about 700 nM, normalized by aerosol mass, corresponding to a v:v aerosol:water dilution ratio of 25,000, a typical cloud water dilution ratio. We will discuss how the OH burst activity depends on chemical composition determined by the Aerosol Chemical Speciation Monitor (ACSM), Particle Soot Absorption Photometer (PSAP) and Single Particle Soot Photometer (SP2) and soluble metals measured using ICP-MS. Results from airmass back trajectories derived from Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) model along with the meteorological data from NCEP Global Data Assimilation System and their insights into the relationship between the degree of cloud processing and the OH burst will also be discussed.

7CC.6

Thermodynamically Constrained Fire Radiative Power Retrieval Approach for Estimating Wildfire Emissions during the 2019 FIREX-AQ Campaign. CHENCHONG ZHANG, Nishit Shetty, Benjamin Sumlin, Rajan K. Chakrabarty, *Washington University in St. Louis*

Biomass burning (BB) degrades regional air quality by emitting tons of gases and particulate matters. Besides the greenhouse gases, BB represents a large source of non-methane volatile organic compounds (NMVOCs), which will further form secondary organic aerosol (SOA) by gas-phase oxidation and vapor-pressure-driven partitioning. BB primary emissions have been widely estimated by the bottom-up approach, which is the product of the burned area, the fraction of burned biomass, biomass fuel load, and the specific emission factors. However, the burned areas are frequently underestimated by the existing subpixel algorithms compared to in situ measurements. Here we synergistically integrate the high-spatiotemporal-resolution fire radiative power (FRP) with a comprehensive soil heat transfer model to accurately estimate the primary pollutant emissions during the 2019 Fire Influence on Regional to Global Environments and Air Quality (FIREX-AQ) campaign. We resolve the diurnal FRP cycle of large-scale fires at a 5-min interval from the Geostationary Operational Environmental Satellite (GOES). FRP of other small-scale wildfires captured by Moderate Resolution Imaging Spectroradiometer (MODIS) and Visible Infrared Imaging Radiometer Suite (VIIRS) are extrapolated based on the similar diurnal pattern retrieved by GOES. The fused datasets of FRP by both geostationary and polar-orbiting satellites are incorporated into our thermodynamically-constrained retrieval model to resolve the fire area which contributes primary emissions, and a complete temperature profile of both the fire area and adjacent heated land. The estimated primary emissions of greenhouse gases and particulate matters show improved correlation with the integrated airborne in situ measurements. The computed NMVOC emissions are input into a regional chemical transport models to give a reliable estimation of total particulate matter emissions.

7IA.1

Impacts of Professional Cleaning Activities on Indoor Particulate Matter Following a Wildfire Event. Avery Hatch, LIORA MAEL, Marina Vance, *University of Colorado Boulder*

Wildfire events have increased in length and severity over the years, contributing significant amounts of particulate matter (PM) pollution outdoors and to indoor environments. While guidelines encourage people to remain in their homes during wildfire events, wildfire PM can infiltrate homes, affecting indoor air quality, and potentially causing visible soot and ash deposition within living areas. There is a pressing need to understand how post-fire cleaning efforts can affect PM levels in a home. Following the significant Marshall Fire wildfire event in Colorado in January 2022, this study assessed size-resolved PM concentrations in an unoccupied single-family home that had been evacuated and impacted by wildfire smoke, but not structurally damaged. We monitored aerosol size distributions using a scanning mobility particle sizer and an aerodynamic particle sizer before, during, and after professional cleaning activities were conducted in this home. Results show that (1) $PM_{2.5}$ concentrations remained relatively low throughout the duration of the study, (2) cleaning activities caused spikes in indoor PM_{10} and $PM_{2.5}$ concentrations, (3) the operation of the home mechanical ventilation system led to new particle formation events and those particles remained in the ultrafine mode. These findings suggest that indoor PM levels are affected by post-fire mitigation actions, and that if cleaning activities are undertaken by household occupants or professionals, safety precautions should be considered and personal protective equipment would be recommended.

7IA.2

Estimating Airborne Concentration of SARS-CoV-2 RNA Using Quantitative Filter Forensics. Zoe Hoskin, Jeffrey Siegel, SARAH HAINES, *University of Toronto*

The COVID-19 pandemic has had indescribable impacts on human health and wellbeing, causing over six million deaths worldwide. Environmental monitoring of viral outbreaks, surveilling the presence of viral RNA through media in the environment, has mainly been limited to wastewater analysis and bulk floor dust analysis. However, wastewater analysis is limited to large-scale community surveillance and does not allow for building or room level analysis which is critical to understanding and preventing disease spread. Additionally, though bulk floor dust sampling in buildings does allow for room-level monitoring, dust samples are likely biased towards larger respiratory particles and respiratory particles attached to dust due to deposition. We designed a targeted sampling approach for indoor airborne dust that is inclusive of particle size using established quantitative filter forensics techniques. Portable air filters were deployed for approximately 14 days in both high-traffic areas at the University of Toronto and other community environments as well as within homes of individuals who tested positive for COVID-19. Dust from filters was collected via vacuum extraction, viral RNA was extracted and presences of SARS-CoV-2 was detected and quantified using real time quantitative reverse transcription-PCR (RT-qPCR). Utilizing the flow rate through the filter, the filter efficiency, mass of dust, duration of deployment and quantity of SARS-CoV-2 RNA we were able to estimate the airborne concentration of SARS-CoV-2. Initial results revealed concentrations of SARS-CoV-2 RNA ranging from 0.01 – 1.6 RNA copies/m3 air within rooms of positive individuals. Further work may elucidate the effectiveness of this technique in building level environmental monitoring for COVID-19 and other airborne diseases.

7IA.3

Bioaerosol Control in Urban Elementary School Classrooms with In-room HEPA Supplements: Distribution of Effectiveness, Contribution to Room-Air Mixing and Acoustic Envelope Assessment. Odessa M. Gomez, Halle Sago, Anna Segur, Sylvia Akol, MARK HERNANDEZ, *University of Colorado, Boulder*

The need to reduce airborne (biological) particle exposures in urban public schools is evident. In response, we report here a systematic ventilation and air-mixing assessment of classrooms distributed across more than 20 buildings in a large US school district. We report the effect of deploying a new generation of HEPA air purifiers on the fluorescent fractions of airborne respirable particulate matter (PM_{BIO}) as well as acoustic impacts in 75 elementary school classrooms before and during their occupation.

Food grade carbon dioxide gas was used to determine the mixing regime and effective air exchange provided by the ventilation system classrooms under the following conditions: doors closed and open, as well as with and without in-room air purifying filters engaged (RMAP, Carrier Global, Indianapolis, IN). Real-time, multiple-channel fluorescent aerosol cytometers (InstaScope, DetectionTek, Boulder, CO), positioned in each classroom monitored the total and biological fractions of airborne PM, through at least three consecutive air exchanges, before, during and after students' occupation. Using accepted non-parametric tests (Kruskal-Wallace), the airborne (bio)aerosol loads were compared in occupied classrooms with operating air purifiers engaged during instructional periods, to otherwise similar classrooms without air purification equipment installed and to those loads immediately outdoors. The effects of HEPA air purifier operations on room air mixing were assessed by deploying arrays of carbon dioxide monitors symmetrically in the classrooms at childrens' breathing height. The acoustic projection of the HEPA air purifiers as deployed were compared to the cumulative background sound pressure in the classrooms using radial meters. These metrics were juxtaposed to teachers' surveys and student absenteeism.

As judged by in-situ sound pressure, the acoustic envelope projected by the air purifiers was less than 10% of the background; all sound emissions fell within a range that does not interfere with classroom communications under World Health Organization (WHO) guidelines. Tracer gas patterns showed that a substantial fraction of classrooms surveyed were not operating under well-mixed conditions, and that air purifiers could have a measurable effect on air mixing where air exchange was less than 5 hr^{-1}. As judged by real-time fluorescent cytometry of occupied classroom air, HEPA air purifiers processing 500 ft^3/min of room air were able to sustain significantly reduced bioaerosol loads in occupied classrooms. Teacher surveys indicated that acoustic impacts and air purifier placement drive faculty acceptance of HEPA air purifier operations. Results suggest that distributed networks of smaller air purifiers are preferred over larger units in practice.

7IA.4

Impact of Operating Room Ventilation on Particle Elimination in Proximity under Realistic Settings. MUCHUAN NIU, Haoxuan Chen, Jonathan Liu, Chi-hong Tseng, John Shin, Nir Hoftman, Yifang Zhu, *University of California, Los Angeles*

During the COVID-19 pandemic viral particle transmission via pulmonary aerosol has created enormous risks for healthcare workers (HCWs) in the operating room (OR). The ventilation system in the OR is one of the main means of reducing particle contamination and preventing surgical site infection (SSI). Published studies on the effectiveness of OR ventilation systems were generally conducted in experimental conditions and the particle number concentration (PNC) at different distances from the source has yet to be characterized.

To assess the function of the OR ventilation in a real-world setting, we recruited 40 patients going into elective surgery and sampled particles generated from a saline nebulizer at three different locations during induction of general endotracheal anesthesia. The nebulizer source was placed at the head area of the surgical table. The first sampling location was 0.6 m from the nebulizer laterally on the opposite side of the table. The other two sampling locations were 0.8 and 1.0 m apart from the nebulizer, representing the locations of the anesthesiologist's and medical assistant's faces, respectively. For each patient, a total of five sampling sessions were designed to compare the PNCs under different patient and physician activities. Results showed that at 1 m from the source, significantly lower PNC levels (~ 300 particles/cm3) were observed compared to the other two locations. The decay rate at 0.8 m from the nebulizer was significantly higher than the other two locations when the nebulizer was turned off, suggesting greater ventilation efficacy at the anesthesiologist's location. Modelling results of factors that affect decay rate are to be reported. Our results under realistic OR settings suggest relatively smaller particle exposure risk at further distances from the particle source; while particles were removed more rapidly at the anesthesiologist location, which is likely dependent upon the ventilation system's airflow.

7IA.5

Fixed and Adaptive Concentration Threshold for Particle Filtration Systems. Alexander Mendell, Alexander Olson, JEFFREY SIEGEL, *University of Toronto*

Particle filtration can effectively reduce indoor concentrations of particulate matter (PM), but may incur high energy use. One approach to minimize energy use is to operate particle filters only when concentrations exceed a threshold. However, such approaches are complicated by the diversity of indoor environments and contexts limiting the applicability of universal thresholds. To address this need, this study evaluates fixed and adaptive concentration thresholds to automate the operation of filtration systems. Simulated environments were derived from week-long continuous PM measurements from two types of low-cost particle counters deployed in apartments (n=204) in Toronto. A fixed threshold of 4.0 µg·m-3 resulted in a mean air cleaner runtime of 6.9% to 21.0% depending on clean air delivery rate (CADR) and particle sensor, while providing mean concentration reductions of 67% to 71% compared to operating the air cleaner constantly (runtime = 100%). In most environments, runtime could be further reduced by raising the fixed threshold while resulting in only a modest decrease in absolute and normalized mean exposure reduction. These results were generally insensitive to cleaning power and the monitor used to measure particle concentrations. Using an adaptive threshold derived from a k-means clustering approach generally further increased exposure reduction while preventing high runtimes, further increasing benefit. Reducing the energy usage of particle filter systems will make them a more viable and sustainable means of improving occupant health.

7IA.6

Mixing and Dispersion of Aerosols in Multi-Zone Residences. MENGJIA TANG, Daniel Rush, Sangeetha Kumar, Atila Novoselac, *The University of Texas at Austin*

Exposure to particulate matter (PM) in homes typically accounts for a large proportion of a person's total daily exposure. Various indoor activities including cooking, cleaning, and walking can substantially increase the PM level and overall exposure. To accurately estimate, and subsequently reduce PM exposure due to PM releasing events, it is essential to understand the transport of aerosols across different zones in a common multi-zone residential environment. Depending on the longevity of the PM source, PM size, and ventilation and mixing mechanisms in the residence, there can be a high variation in PM exposure across different rooms. This study used controlled experiments in the full-scale three-bedroom two-bath home that is used as a testing facility at the University of Texas at Austin. Concentrations of ultrafine (<0.1 µm), fine (0.3 – 2.5 µm), and coarse particles (2.5 – 10 µm) were measured in multiple rooms during and following different types of PM generation. Together with the particles, tracer gas was released, and the temporal concentration was measured in each room. The PM generating event mimicked instantaneous (less than 1 minute), short-term (15 minutes), and long-term (2 hours) PM sources released in a kitchen; the fate of particles of different sizes as well as the tracer gas was determined for different levels of air mixing in the home (the air conditioning fan ON and OFF). Preliminary results suggest that ultrafine particles follow the same pattern regardless of the level of air mixing while air mixing has a large impact on the dispersion of fine particles. The dispersion of coarse particles throughout the house is relatively small.

7ID.1

Evolution of SARS-CoV-2 Shedding in Exhaled Breath Aerosols. KRISTEN K. COLEMAN, Jianyu Lai, Sheldon Tai, Jennifer German, Filbert Hong, Barbara J. Albert, Yi Esparza, Aditya Kiran Srikakulapu, Maria Schanz, Isabel Sierra Maldonado, Molly Oertel, Naja Fadul, Louie Gold, Stuart Weston, Kathleen McPhaul, Matthew B. Frieman, Donald K. Milton, *University of Maryland School of Public Health*

Transmissibility of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) continues to increase as new variants emerge. Is increased transmissibility associated with increased viral aerosol shedding? From June 2020 through March 2022, we collected exhaled breath aerosol (EBA) samples from 93 volunteers (ages 6-66) with mostly mild SARS-CoV-2 infections. A Gesundheit-II was used to collect *fine* (≤5 µm in diameter) and *coarse* (>5 µm) EBA using a 30-minute loud speaking/singing protocol. Samples were assayed using TaqPath COVID-19 Real-Time RT-PCR Assay (Thermo Scientific) and cultured using TMPRSS2-expressing VeroE6 cells and A549-ACE2 cells. SARS-CoV-2 RNA was detected in EBA from 44 (47%) of the participants. Infectious SARS-CoV-2 was recovered from EBA of six participants, including one B.1.2, one Alpha, two Delta, and four Omicron infections, three of whom were singly boosted. Infectious virus was recovered from seven *fine* and one *coarse* EBA sample. All Delta and Omicron cases were fully vaccinated (63% boosted). The strongest predictors of *fine* EBA viral RNA load were SARS-CoV-2 variant, systemic symptom score, saliva viral RNA load, age, and coughs during collection. Overall, *fine* EBA viral RNA loads were similar for Alpha, Delta, and Omicron. No significant difference in EBA load was observed between Omicron subvariants (BA.1, BA.1.1, and BA.2); the maximum was $1.8x10^7$ RNA copies of Omicron BA.1.1. Alpha, Delta, and Omicron are associated with increased viral shedding in *fine* EBA, compared with ancestral strains and variants not associated with increased transmissibility. Evolutionary selection for immune evasion *and* high viral aerosol shedding appears to be occurring. Because vaccination and boosting cannot prevent shedding of infectious virus via aerosols, non-pharmaceutical interventions including ventilation, filtration, and germicidal UV air disinfection are still needed to mitigate COVID-19 transmission and protect vulnerable populations.

7ID.2

Absolute Respiratory Particle Number and Mass Exhalation Rates and Size Distributions during Breathing and Vocalizing. Justice Archer, Henry Symons, Lauren McCarthy, Joshua Harrison, Christopher Orton, Natalie Watson, William Browne, Ben Moseley, Kier Philip, James Calder, Pallav Shah, Declan Costello, Bryan R. Bzdek, JONATHAN P. REID, *University of Bristol*

The coronavirus disease (COVID-19) pandemic has reinforced the need to understand the transmission of respiratory pathogens by aerosols. Aerosol particles of varying size are exhaled during respiratory activities like breathing while at rest or during exercise, speaking and singing, and can transmit pathogens if emitted from an infected individual. Improved quantification of exhalation rates would support estimates of viral shedding and assessments of transmission risk. Previous studies report aerosol concentrations in an exhaled plume; we report here absolute particle exhalation rates from combined measurements using cardiopulmonary exercise testing with exhaled particle concentrations.

We will summarise measurements from the project PERFORM-2 (The Investigation of Particulate Respiratory Matter to Inform Guidance for the Safe Distancing of Performers in a COVID-19 Pandemic) and from these cohorts of participants: professional singers and wind instrumentalists, children (aged 12-14) singing, individuals undergoing speech and language therapy tasks, and adults exercising. Measurements were made in a zero-background orthopaedic operating theatre to ensure all aerosol particles detected (<20 µm diameter) originate from the participant. We will also summarise measurements of larger particle size using water sensitive paper (extending from 20 to >500 µm). We will address the unique challenges that must be overcome when measuring exhaled aerosols such as Poisson arrival statistics for particles at the very low concentrations present in exhaled breath.

All cohorts generate similar emission rates from the same activity, but vocalisation generates significantly more particles than breathing. Exhalation rates of particles (<20 µm diameter) are typically 0.01, 0.1 and 0.5 ng s^{-1} from breathing, speaking and singing, increasing with loudness. Size distributions when exercising are similar to breathing, and mass emission rates are comparable to vocalising at conversational volume, despite increased minute ventilation. We will also examine the correlation between the exhaled flux of carbon dioxide and aerosol mass across all activities, including for high impact exercise.

7ID.3

Say It Don't Spray It! Large Droplet Emissions from Speaking, Singing, and Playing Wind Instruments. KY TANNER, Kristen Good, Dan Goble, Nicholas Good, Amy Keisling, Christian L'Orange, Emily Morton, Rebecca Phillips, John Volckens, *Colorado State University*

At the onset of the COVID-19 pandemic, the leading mitigation strategy endorsed by public health experts was 6’ physical distancing coupled with regular hand hygiene. Since then, we have learned that the primary transmission mode for the virus is through the airborne transmission of aerosols (dp < 100 µm) and/or “ballistic” droplets (dp > 100 µm) that emanate from the human respiratory tract. This work sought to characterize the emission rate and size distributions of large droplets (dp > 20 µm in aerodynamic diameter) produced by a panel of 53 volunteers while talking, singing, and playing wind instruments, with and without face masks (while singing) and bell covers (while playing wind instruments). Participants performed these activities inside a cleanroom, with droplet emissions sampled via water-sensitive-paper cards in the immediate vicinity of their mouth (or instrument bell). Cards were analyzed using a microscope and image processing software (ImageJ) to determine number and size distributions. We modeled droplet size and concentration at the point of release, accounting for travel distance, dispersion, settling, and evaporation. Average particle emission rates varied from 5.3/min (SD = 3.3/min) for singing with a mask to 178/min (SD = 181/min) for talking without a mask. On average, talking produced the most droplets followed by singing without a mask and then instrument playing (negligible difference between with and without bell covers). However, we found large variations in emissions between individual participants for every performance category. Age and sex were not significant predictors of emissions, contrary to previous findings for smaller particle sizes. Size distributions were similar across performance categories (CMD = 55.5 µm, GSD =2.09). Bell covers did little to mitigate large droplet emissions from most wind instruments, but face masks greatly diminished large droplet emissions associated with singing.

7ID.4

Characterizing and Comparing Respiratory Aerosol Emission for Pre-adolescent, Adolescent, and Adults during Sustained Phonation. MAHENDER SINGH RAWAT, Mehtap Agirsoy, Tanvir Ahmed, Byron D. Erath, Goodarz Ahmadi, Dinushani Senarathna, Sumona Mondal, Andrea Ferro, *Clarkson University*

Respiratory activities such as coughing, breathing, singing, sneezing, and speaking release aerosols 0.1-100 µm in diameter, with a mean diameter of ~1 µm for vocalization activities. Several research groups have reported particle production rates for respiratory activities as a function of both loudness and frequency. Few studies, however, have included children, which has restricted understanding of exposure risk in environments occupied primarily by children, such as schools. Respiratory aerosols arise due to bronchial fluid film bursting within the pulmonary tract, vibration of the vocal folds during phonation, and articulation of the tongue/lips/teeth. We expect children's respiratory aerosol generation rates to be lower than adults’ due to the smaller size of their laryngeal structure and reduced subglottal pressure created during speech. We recruited 35 healthy, untrained singers (14 females and 21 males) ages 6 -18 years, as well as 16 adults (8 females and 8 males) ages 20 - 60 years. We investigated particle emissions for vocalizations at 262 Hz (middle C, or C4, on a keyboard) for three different 5-second activities (normal sustained /a/, deep breath followed by sustained /a/, and /pa/ repeated at ~1 Hz). All activities were repeated 6 times. Throughout all of the trials, the rate of respiratory particle generation ranged from 0 to 82 particles per second (#/s). Pre-adolescent children produced fewer particles (mean ± SD equal to 1.8 ± 1.6 #/s) than adolescent children (mean ± SD equal to 4.7 ± 3.5 #/s), who produced fewer particles than adults (mean ± SD equal to 36.9 ± 73.0 #/s). Normal /a/ produced the fewest particles while taking a deep breath prior to producing /a/ generated the most particles for all age groups. Three superemitters (statistical outliers) were found in the adult group, two superemitters in the adolescent group, and three in the preadolescent group.

Keywords: respiratory emission; COVID-19; aerosols; transmission; children, superemitters

7ID.5

Estimation of Direct Human Contribution to the Aerobiome Composition of Indoor Environments. AUSTIN MARSHALL, Suresh Dhaniyala, Shantanu Sur, *Clarkson University*

Bioaerosols of the built environment can be substantially influenced by anthropogenic factors with estimations that 5 - 40% of the microbial DNA from indoor bioaerosols are attributed to human sources. However, much less information is available on the impact of human occupancy to microbial composition in the air. Airborne transmission of pathogens stemming from the recent pandemic has generated a strong interest toward better understanding the microbial release in the air from humans. Apart from occupant numbers, several other factors such as human activities (e.g., speaking, singing), practices (e.g., wearing mask), and air exchange rates can potentially influence the human contribution to the microbial composition in air. To assess the impact of these factors, we captured bioaerosols from indoor spaces using a low-power, low-flow rate, portable electrostatic sampler and performed downstream analysis by real-time PCR and long-read nanopore sequencing. First, we developed an optimized workflow for sample processing and 16S ribosomal RNA gene sequencing that allowed us to reliably measure bacterial abundance and diversity in air from a very low biomass bioaerosol sample. To assess the human contribution to the bacterial load, human RNase P gene and bacterial 16S genes were targeted and quantified in tandem using real-time PCR. The absolute number of RNase P and 16S rRNA gene copies were used to measure the extent of direct human contribution within each sampling location. We have collected and analyzed bioaerosol samples from Clarkson University, focusing on the classroom environment in an attempt to observe abundance and diversity variations due to masked and unmasked students. We compared these samples on the basis of their microbial composition and assessed the human contribution to the differences observed. The knowledge gained from this study could help in deciding context-specific actionable measures to prevent airborne transmission of disease.

7ID.6

Viable SARS-CoV-2 Delta Variant Detected in Aerosols in a Residential Setting with a Self-Isolating College Student with COVID-19. WILLIAM VASS, John Lednicky, Sripriya Nannu Shankar, Z. Hugh Fan, Arantzazu Eiguren-Fernandez, Chang-Yu Wu, *University of Florida*

By September 2021, the B.1.617.2 (Delta) variant of SARS-CoV-2 comprised over 99% of genome-sequenced COVID-19 cases of the United States. The rise in cases due to the Delta variant, which coincided with a return to in-person school attendance, strained mitigation plans implemented by educational institutions. Some plans required sick students to self-isolate off-campus, which may potentially result in unintended exposure of cohabitants during self-isolation.

We collected air and surface samples from a single-family home used by a self-isolating university student with mild COVID-19 to assess the presence of SARS-CoV-2. We deployed the three-stage NIOSH bioaerosol sampler (Model BC-251), which allowed aerosol particle size fractionation by using dual cyclone stages and a final filter stage (Cao et al., 2010). We also used a Bio-Spot Viable Virus Aerosol Sampler (BioSpot-VIVAS), which collects viruses using water condensation growth technology (CGT) and improves virus preservability (Lednicky, et al., 2020). We placed air samplers >2 m away from the student who was resting on their bed. Dual sampler types were used to improve the chances of maintaining virus viability and to discern the distribution of particle sizes containing SARS-CoV-2. In addition, high-touch surfaces were sampled using sterile nylon swabs.

SARS-CoV-2 RNA was detected by reverse-transcription polymerase chain reaction (RT-PCR) in air samples from both the isolation bedroom and a distal, non-isolation room. Results from the size-fractionated sampling revealed that SARS-CoV-2 was primarily within particles with diameters < 4.4 µm. This is significant because particles in that size range are capable of passing ciliated airways and potentially infecting cells within the lower respiratory tract (Pan et al., 2019). Among eight collected surface samples, only the swab taken from the student's mobile phone resulted in SARS-CoV-2 detection. Viable SARS-CoV-2 in air samples collected by BioSpot-VIVAS (292 PFU/L and 132 PFU/L) and the phone swab (1000 PFU/cm2) was isolated for further analysis. Genomic sequencing revealed that the virus was a Delta variant.

This work confirmed the presence of viable SARS-CoV-2 within and beyond the isolation bedroom of a person with COVID-19, which shows potential risk of transmitting virus beyond isolation spaces in residences through the airborne route. The results also showed improved ability to culture SARS-CoV-2 with the CGT method relative to cyclones and filters.

7IM.1

A Community Ice Nucleation Cold Stage Instrument for Research and Teaching. MARKUS PETTERS, Sunandan Mahant, Shweta Yadav, Tommy Kessler, Eva Kjærgaard, Mads Jensen, Merete Bilde, *North Carolina State University*

This work presents a community ice nucleation cold stage instrument for research and teaching purposes. The instrument is suitable for studying ambient ice nucleating particle concentrations and laboratory-based process-level studies of ice nucleation. The instrument is part of a suite of U.S. NSF sponsored laboratory instruments that can be requested by principal investigators through the Facilities for Atmospheric Research and Education (FARE) Program. In addition to introducing the requesting process, we present the validation data and the design plans of the instrument. The plans allow individuals to self-manufacture a cold-stage using 3D printing, off-the-shelf parts, and a handful of standard tools. Software to operate the instrument and analyze the data is also provided. The underlying principles include that the design and software is open, adaptable, and free of most license restrictions. The design is intended to be simple enough that a graduate student can build it as part of a course or thesis project. Costs are kept to a minimum to facilitate use in classroom demonstrations and laboratory classes.

7IM.2

A New Size-fractionated Liquid Collection of Viable Airborne Particles: The BioCascade Impactor. Stavros Amanatidis, Nathan Kreisberg, ARANTZAZU EIGUREN-FERNANDEZ, *Aerosol Dynamics Inc.*

Viral respiratory diseases spread from person to person by droplets coughed or sneezed into the air. Larger particles settle quickly and land on objects and surfaces around the person, while smaller particles (<5µm) remain suspended for longer periods and travel farther distances, thereby prolonging the risk for acquiring an infection and increasing the likelihood of community transmission. Identifying the transmission modes for respiratory viruses is critical to establish effective control protocols to limit transmission.

We have developed a new system, the BioCascade Impactor, for simultaneous liquid collection of viable airborne microorganisms present in three particle size fractions: >10 µm, PM_{4-10}, $PM_{1.5-4}$. The BioCascade combines multiple stage size-classification and particle collection by gentle impaction into liquid. Aerosol samples are collected at a flowrate of 8 L/min and sequentially passed through impaction stages of decreasing size cutpoints. Particles smaller than 1.5 µm can be further collected by passing the sample into a VIVAS, filter or other collection system, operating at the same flowrate. The BioCascade combines established guidelines for impaction on solid, flat surfaces, while maintaining low-enough flow velocities to avoid unstable air jet-liquid interface. To avoid potential liquid transfer between stages, the collection containers are placed on the same planar level and are connected through aerodynamically gentle inter-stage flow passages. The design was optimized with 3D finite element simulations of flows and particle trajectories using COMSOL Multiphysics.

The performance of the BioCascade was be tested in the laboratory following previously established protocols using polystyrene latex spheres with NIST-certified sizes, fluorescein particles and laboratory generated ammonium nitrate particles, in conjunction with an Aerodynamic Particle Sizer (APS) (TSI Model 3021, Minnesota) and water-based Condensation Particle Counters (WCPC) (ADI, California) for monitoring particle size and concentration. The cut-off size of each impactor was first characterized separately, followed by the evaluation of the complete BioCascade.

7IM.3

A Cost-Effective Tabletop Chamber to Evaluate Cloud Microphysical and Optical Properties. JAKE ZENKER, Christian Pattyn, Lekha Patel, Jeremy Wright, Andres Sanchez, Brian Bentz, Andrew Glen, *Sandia National Laboratories*

We have developed a tabletop cloud chamber that can be used to study microphysical and optical properties of cloud droplets generated using different techniques under a wide array of initial conditions. The plexiglass chamber is 15” x 18” x 48”. Droplets can be generated mechanically by dispersing water-solute droplets through a nozzle. Alternatively, mixing clouds can be generated via the injection of a heated humidified flow and desiccated cloud condensation nuclei (CCN) particles. A cooling coil is installed at the base of the chamber which can be used as a coarse control of the temperature inside of the chamber. The temperature and flow rate of the heated humidified air can also be used for fine control of the chamber’s relative humidity and temperature. Further, the humidified flow can be utilized to impose mechanically and thermally generated turbulence.

The chamber is equipped with instrumentation that measures droplet and CCN size distributions, CCN hygroscopicity, and the vertical component of droplet velocity. Additional instruments have been incorporated into the platform to study the bulk optical transmission, scattering, and absorption properties of clouds. The highly modifiable design of the platform promotes the future implementation of additional diagnostic tools.

Experiments have been conducted in the chamber demonstrating droplet growth and evaporation that is consistent with theoretical expectations under different temperatures, relative humidities, and dry aerosol concentrations. Ongoing work is being conducted to rigorously characterize supersaturation conditions in the chamber based on CCN hygroscopicity and initial droplet growth rate.

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7IM.4

Practical Characterization of a Novel Moderated Water Condensation Growth Tube Bioaerosol Sampler. DOMINICK HESKETT, Tim Gordon, Braden Stump, Patricia Keady, *Aerosol Devices Inc.*

The Biospot-GEM™ bioaerosol sampler was developed in response to the COVID-19 pandemic as an easy-to-use, inexpensive, yet performant bioaerosol sampler for interfacing with existing biological analysis workflows such as culturing/infectivity assessment, genomic sequencing, and RT-qPCR. Traditional bioaerosol samplers, such as filters and impactors, damage biological particles through mechanical stresses and desiccation negatively effecting the vitality of the captured biological material. Moderated water condensation growth capture eliminates these sampling risks and better maintains sample integrity of the biological materials. This sampler can be adapted to collect a concentrated sample onto a solid substrate, onto a sterile swab (patent pending), and into liquid depending on downstream processes. Swab and liquid collection allow for sampling into a genomic preservative (Nieto-Cabellero et. al. 2018, patent pending) or artificial saliva prior to collection to preserve sample fidelity at the moment of capture. In this presentation, we will discuss sampler design and performance characteristics including collection efficiency of the sampler as a function of particle size and collection terminus. With FEA modeling of the impaction nozzle, we increased the capture efficiency for sampling into liquid to be comparable to the capture efficiency of solid sampling with the same instrument.

7IM.5

Characterization of the MAGIC CPC to Measure Nanometric Carbonaceous Aerosols Sampled from a Sooting Laminar Premixed Flame. FARNAZ KHOSRAVI, Arantzazu Eiguren-Fernandez, Gregory S. Lewis, Michel Attoui, Francesco Carbone, *University of Connecticut*

One of the major contributors to pollution in urban areas is carbonaceous materials emitted from combustion sources that are known to impact human health and climate change. Consequently, the total mass concentration of particulate matter is stringently regulated but the smallest, most numerous, and likely, most toxic nanoparticles are not controlled by the existing legislation because of the lack of reliable standardized detection approaches. Condensation Particle Counting (CPC) is one of the most attractive technologies for implementing the needed monitoring of the smallest particles in the atmosphere thanks to some distinctive features such as reliability, affordability, and the ability to directly measure the particle number concentrations with a large dynamic range. The water-based MAGIC CPC is a particularly attractive option because of its low usage of a non-toxic odorless condensing fluid and the minimal power consumption but water condensation is known to be influenced by the chemical composition (e.g., hygroscopicity) of the particles and its widespread use requires the characterization of the detection efficiency for the smallest nanoparticles originating from combustion sources. In this study, such efficiency has been characterized by relying on incipient soot particles generated from a laminar premixed flame which are size classified using a Half-Mini Differential Mobility Analyzer (DMA) after being sampled and diluted from the flame. Results show that the MAGIC CPC can be readily operated to activate the condensation growth and detection (with a 50% efficiency) of flame particles at least as small as 3nm. The detection efficiency is slightly sensitive to the polarity of particles classified by the DMA with an enhanced detection of particles with a positive charge. Results also suggest that further improvements in the detection efficiency of the smallest particles are achievable by implementing approaches to reduce particle diffusion losses and increase the supersaturation ratio and available condensation growth time in the MAGIC CPC.

7IM.6

Evaluation of a Condensation Particle Counter Method for Measuring Sulfuric Acid Vapor Concentrations. DOMINIC CASALNUOVO, Darren Cheng, Coty Jen, *Carnegie Mellon University*

Freshly formed particles from sulfuric acid nucleation affect the Earth's radiative balance by forming cloud condensation nuclei (CCN). Accurately predicting global sulfuric acid nucleation rates requires high temporal and spatial resolution measurements of gaseous sulfuric acid. Accomplishing this is challenging due to the difficulties in deploying a chemical ionization mass spectrometer (CIMS) in remote regions of the atmosphere. We have developed a complementary technique to measure sulfuric acid vapor concentrations (SA-CPC). The SA-CPC consists of a compact nucleation flow reactor that uses dimethylamine to convert atmospheric sulfuric acid vapor into measurable 1-nm particles in a controlled environment. The concentration of particles is measured using a 1-nm condensation particle counter and converted to sulfuric acid concentration using a semi-empirical acid-base nucleation model. We present operational details on the SA-CPC, including computational fluid dynamic simulations of the nucleation flow reactor. In addition, laboratory comparisons of SA-CPC measured sulfuric acid concentrations (10^6-10^8 cm^{-3} range) compared to those measured by the CIMS are shown. Results demonstrate that the SA-CPC measures sulfuric acid concentrations within 12% of those measured by the CIMS, with larger discrepancies at higher sulfuric acid concentrations. In addition, the effects of relative humidity, temperature, and presence of other potential nucleation precursor compounds were explored to determine how these parameters impact SA-CPC measured sulfuric acid concentrations. Overall, the SA-CPC is a helpful instrument in obtaining atmospheric sulfuric acid vapor concentration measurements in diverse locations around the world.

7PC.1

The Physical and Chemical Nature of Ice Nucleating Macromolecules.

HINRICH GROTHE, *TU Wien, Institute of Materials Chemistry, Vienna, Austria*

Biological aerosols are known as efficient heterogeneous ice nuclei. However, little is known about the physical and chemical specifica responsible for this effect. In 2012 Pummer et al. could show that it does not need a whole pollen grain but that water-soluble macromolecules can be separated from the original grain and the ice nucleation efficiency remains the same. On the basis of vibrational spectroscopy the same authors (Pummer et al 2013) concluded that polysaccharides are the crucial ice nucleating macromolecules (INM). Subsequently, several authors have tried to unravel the puzzle of the chemical nature of INM. Only recently, Failor et al. (2022) found that polyketide synthase and non-ribosomal peptide synthetase can be washed down from a Gram-positive bacterium acting as INM, while Burkart et al. (2021) washed down proteins from subpollen particles (SPP) which range from 77.4 µg mL−1 (highly concentrated INMs) to below 2.5 µg mL−1 (purified SPPs). Interestingly, INM were found on the surface of the whole tree and do not exclusive occur on pollen surfaces (Felgitsch et al. 2018). Additionally, INM were also detected in the aerosol phase next to the trees during precipitation events (Seifried et al. 2020).

This presentation will summarize all recent findings and will try to draw conclusions regarding chemistry and nucleation mechanism.

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7PC.2

Influence of Surface Properties on Heterogeneous Ice Nucleation in Synthesized Crystalline, Porous Materials.

LUCY NANDY, Katie Marak, Miriam Freedman, *Pennsylvania State University*

Heterogeneous ice nucleation activity is affected by aerosol particle composition, crystallinity, pore size and surface area. However, these surface properties are not well understood with regard to how they affect cloud droplets by forming ice. Therefore, synthesized materials like zeolites and covalent organic frameworks (COFs), for which surface properties can be tuned, were studied in immersion freezing mode. The materials in powder form were dispersed in water, droplets were pipetted onto a hydrophobic glass slide, and the slide was then placed in a temperature- and humidity-controlled chamber to record the freezing events. To establish the relationship between the physical and chemical properties of the particles and efficiency of ice nucleation, materials with different compositions (e.g. Si/Al ratio for the zeolites), pore size, surface area and crystallinity were characterized using XPS, BET, and XRD. Results show that COFs with pore sizes between 2 and 3 nm exhibit the most efficient ice nucleation activity. For zeolites, the Si/Al ratio showed a strong correlation with the ice nucleation efficiency, lower ratios being more efficient. The results will be compared and discussed in the context of numerous other synthesized porous systems. From these laboratory studies, the goal is to develop a predictive model for understanding the most important surface properties that promote ice nucleation.

7PC.3

Effect of Acidity and Liquid-Liquid Phase Separation on Heterogeneous Ice Nucleation. ZIYING LEI, Sarah Brooks, *Texas A&M University*

Aerosol Acidity plays a critical role in heterogeneous chemical reactions and human health, as well as potential impacts on climate by acting as cloud condensation nuclei (CCN) and ice nucleating particles (INPs). However, the effect of acidity on ice nucleation of inorganic and organic aerosols has not been addressed. Recently, studies found that liquid-liquid phase separation of aerosol particles is pH-dependent. The resulting morphology and phase state may, in turn, alter the aerosol's ability to act as INPs.

In this study, our well-established ice nucleation technique combined with Raman micro-spectroscopy is used to study heterogeneous ice nucleation of representative inorganic and organic aerosols under a range of pH conditions (pH -0.1 to 5). Compounds include inorganic (e.g., ammonium sulfate), organic compounds (e.g., sucrose, diethyl sebacate, polyethylene glycol 400, 1,2,6-hexanetriol), and their mixtures. To investigate the potential roles of acidity and liquid-liquid phase separation on ice nucleation, the immersion freezing temperatures of 2 µL sample droplets containing varying amounts of sulfuric acid were determined.

Our results show that increased acidity reduced the ice nucleation ability of droplets containing sulfuric acid and inorganic-organic mixture. Using Raman spectroscopy, changes in the ratio of bisulfate to sulfate were observed to coincide with the changes in ice nucleation temperatures. Possible explanations for the observed changes in ice nucleation temperature are changes in the solubility of the organic component (related to sulfate protonation state), viscosity, and phase. This study aims to improve our fundamental understanding of the effect of acidity on phase separation and ice nucleation, which will lend context to the role of acidity and atmospheric ice cloud formation.

7PC.4

Experimental Verification of Classical Heterogeneous Nucleation Theory with Perfect Wetting, with a Variable Saturation Scanning Condensation Particle Sizer (VSCPS). LUIS-JAVIER PEREZ-LORENZO, Michel Attoui, Charles Brock, Juan Fernandez de la Mora, *Yale University*

In the sheathed Variable Saturation Scanning Condensation Particle Sizer of Gallar et al., seed particles sense a well-defined maximal saturation ratio S_{max}, controlled through the fraction w of a saturator flow combined with a dry flow: $S_{max}=Cw$, though C is unknown. We describe recent improvements to both this VSCPS and the uniformity of the test aerosol, resulting in singularly sharp activation curves $P(w)$ for PolyEthylene Glycol (PEG) 3-9 nm particles in n-butanol. We further determine the unknown proportionality constant C by assuming that the largest particles obey classical nucleation theory with perfect wetting. This turns the measured $P(w)$ into $P(S)$ data, which we compare with classical heterogeneous nucleation theory. Besides C, there is only one adjustable parameter K, the preexponential coefficient entering into the nucleation rate. $P(S)$ curves then agree well with theory between 5 and 7nm. Smaller particles depart slightly from the theory, due to the limitations of the macroscopic model used. The measured $P(S)$ is nevertheless unbiased by the VSCPC, and can be used to test other nucleation theories claiming validity below 5 nm. The predicted widths of the $P(S)$ curves decrease with increasing particle size, while measured widths stop steepening above 7 nm. This saturation is apparently due to limited instrument resolution. Measured widths are nevertheless narrow, with reliable critical supersaturation values that agree well with theory.

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7PC.5

Particle Formation via Droplet Drying: Observing Morphological Evolution and Measuring Aerodynamic Diameter.

DANIEL HARDY, Jim Walker, Pascal Lemaitre, Jonathan P. Reid, *University of Bristol*

The coupled motion and evaporation of droplets and resulting dry particle formation are pivotal in a range of applications. These include powder production in the food and pharmaceutical industries, understanding airborne disease transmission and the quantification and mitigation of risk from aerosolised material in the nuclear industry.

Measuring the evaporation and morphological evolution of individual droplets presents significant technical challenges but is critical for understanding the microphysical processes that determine final particle properties.

This work presents a Falling Droplet Column (FDC) capable of analysing in detail the entire evaporative lifetime of droplets, with a sub-microsecond temporal resolution. The instrument operates by establishing a chain of uniform falling droplets within a temperature and humidity-controlled environment. Multiple exposure stroboscopic imaging enables direct measurement of geometric and aerodynamic diameter of individual particles. Dry particles are deposited at the bottom of the FDC and imaged using SEM.

In this talk we will present evaporative profiles and resulting morphologies over a range of conditions and inorganic salt solutions, detailed images of phase and morphological change and variations in aerodynamic diameter. We will make comparisons with simulations to probe the microphysical parameters governing droplet drying and transport.

7PC.6

Experimental Investigations of Equilibrium and Dynamic Picoliter Droplet Surface Tension.

BRYAN R. BZDEK, Alison Bain, Lara Lalemi, *University of Bristol*

Surfactants are ubiquitous but poorly quantified components of atmospheric aerosols. If sufficiently abundant, they may lower the surface tensions of atmospheric particles and potentially decrease the critical supersaturation barrier, increasing the fraction of aerosol that activates as cloud droplets. However, climate models generally ignore the effects of surfactants, mainly because their concentrations and partitioning behavior in microscopic droplets are poorly constrained. This presentation will describe experimental efforts to comprehensively investigate the surface-bulk partitioning of surfactant-containing picoliter droplets. Droplets 6-10 µm radius containing a surfactant and co-solute (sodium chloride or glutaric acid) are levitated in a holographic optical tweezers instrument. The levitated droplets are coalesced in a controlled manner, and the resulting oscillations in droplet shape provide key information to retrieve the droplet surface tension. Droplet composition is quantified by cavity enhanced Raman spectroscopy of the levitated composite droplet. Surfactants with critical micelle concentrations spanning four orders of magnitude are investigated. These microscopic droplet measurements are compared to macroscopic solution measurements made using the Wilhelmy plate method. The results demonstrate that surface-bulk partitioning in microscopic droplets is highly dependent on droplet size and surfactant identity. In addition, the dynamic surface tensions of surfactant-containing picoliter droplets were studied using a stroboscopic imaging approach, allowing resolution of the dynamic partitioning of surfactant molecules to droplet surfaces on microsecond timescales. These microscopic measurements are reconciled with macroscopic solution measurements by maximum bubble pressure tensiometry. Surfactant partitioning timescales are clearly resolvable over 10s-100s of microseconds and are surfactant dependent, providing useful information regarding the time-dependent composition of the aerosol-air interface.

8AC.1

Understanding Secondary Organic Aerosol Formation of Isoprene and Nitrate Radical Reactions: Role of Oxidants.

TIANCHANG XU, Masayuki Takeuchi, Nga Lee Ng, *Georgia Institute of Technology*

Owing to its abundance in the atmosphere, isoprene and its oxidation products are important constituents in our understanding of atmospheric chemistry. Previous studies have investigated its reactions with nitrate radicals (NO_3) to form secondary organic aerosol (SOA) but focused mainly on how different levels of precursors would affect SOA formation. However, the role of varying oxidant concentrations has not been thoroughly investigated. In this study, we discover that with constant isoprene concentration, the SOA yield and reaction products tend to change with the level of oxidant (NO_3) when VOC:N_2O_5 (oxidant source) ratio varies between 1:1 and 1:14. As oxidant level increases, SOA yield increases from 5.71% (1:1) to 15.2% (1:3) and then remains constant as we further raise oxidant concentration. We attribute such variations to: (1) suppression of SOA formation through first-generational RO_2 unimolecular 1,6 H-shift pathways; (2) enhancement of SOA formation due to multi-generation oxidation. RO_2 unimolecular pathways tend to form more-volatile carbonyl products, hydroperoxyl aldehydes (cis-HPALD-I), and can reduce SOA formation in higher VOC:N_2O_5 conditions as confirmed by both FIGAERO-CIMS measurements and simulated RO_2 fates in 0-D model. On the other hand, when the products undergo multi-generation oxidation in excess NO_3, more oxidized products with lower volatilities will partition more into the particle phase and enhance SOA formation: we identify from FIGAERO-CIMS particle phase results that more oxidized compounds (3N-monomers and 4N-dimers) increase from 4% to 33% of all organic signals, as VOC: N_2O_5 ratio changes from 1:1 to 1:14. However, it is possible that the two effects counteract each other after VOC:N_2O_5 decreases beyond 1:3, which results in a constant SOA yield. Results from this study highlight the importance of considering different degrees of oxidation to assess SOA formation from nitrate radical oxidation of isoprene.

8AC.2

Modeled Impact of Deposition on the Oxidation Pathways of Common Reactive Precursors.

GABRIEL ISAACMAN-VANWERTZ, Chenyang Bi, *Virginia Tech*

The fate of a compound in the atmosphere can be considered as competition between loss processes, particularly oxidation, which propagates chemistry and may form aerosol, and deposition, which removes reactive carbon from participating in further chemistry. The physicochemical properties of modeled and measured atmospheric oxidation products can be used to estimate timescales for these processes. We have previously shown that a substantial fraction of atmospheric organic carbon has competitive timescales for oxidation and deposition, particularly in the case of semi-volatile oxygenated gases that are likely to form aerosol upon further oxidation. We use these timescales here to examine the impacts of deposition on the downstream chemistry in the case of the oxidation of common precursors. Timescales for dry and wet deposition are implemented as first-order processes into a 0-d box model of the photochemical oxidation of α-pinene and other hydrocarbons, enabling the quantification of the fraction of oxidant reactivity and formation potential of secondary organic aerosol that is removed or prevented by deposition. We find that a significant fraction of both reactivity and aerosol formation potential is removed by deposition, with dry deposition generally outcompeting wet deposition. We will discuss the implications of this result for local and regional atmospheric composition.

8AC.3

Tight Coupling of Surface and In-Plant Biochemistry and Convection Governs Key Fine Particulate Components over the Amazon Rainforest.

MANISHKUMAR SHRIVASTAVA, Quazi Rasool, Bin Zhao, Mega Octaviani, Rahul Zaveri, Alla Zelenyuk, Brian Gaudet, John Shilling, Johannes Schneider, Christiane Schulz, Ying Liu, Scot T. Martin, Jianhuai Ye, Alex Guenther, Rodrigo Souza, Martin Zoeger, Martin Wendisch, Ulrich Pöschl, *Pacific Northwest National Laboratory*

The Amazon rainforest plays important roles in the Earth's radiative balance, clouds and water cycle. A key aspect of forest-atmosphere interactions, which is not well understood, relates to how organic gases emitted by the forest form secondary organic aerosols. Understanding how the forest produces these particles could help us understand how deforestation and changing climate will affect global warming and the water cycle.

Combining unique high-altitude aircraft measurements and detailed regional model simulations, we show that in-plant biochemistry plays a central but previously unidentified role in fine particulate-forming processes and atmosphere–biosphere–climate interactions over the Amazon rainforest. Isoprene epoxydiol secondary organic aerosols (IEPOX-SOA) are key components of sub-micrometer aerosol particle mass throughout the troposphere over the Amazon rainforest and are traditionally thought to form by multiphase chemical pathways. Here, we show that these pathways are strongly inhibited by the solid thermodynamic phase state of aerosol particles and lack of particle and cloud liquid water in the upper troposphere. Strong diffusion limitations within organic aerosol coatings prevailing at low temperatures and low relative humidity in the upper troposphere strongly inhibit the reactive uptake of IEPOX to inorganic aerosols. We find that direct emissions of 2-methyltetrol gases formed by in-plant biochemical oxidation and/or oxidation of deposited IEPOX gases on the surfaces of soils and leaves and their transport by cloud updrafts followed by their condensation at low temperatures could explain over 90% of the IEPOX-SOA mass concentrations in the upper troposphere. Our simulations indicate that even near the surface, direct emissions of 2-methyltetrol gases represent a ubiquitous, but previously unaccounted for, source of IEPOX-SOA. Our results provide compelling evidence for new pathways related to land surface–aerosol–cloud interactions that have not been considered previously.

8AC.4

Insights into the Alkene Triol Conundrum: Characterization and Quantitation of Isoprene-Derived C5H10O3 Reactive Uptake Products.

MOLLY FRAUENHEIM, Melinda Beaver, John Offenberg, Zhenfa Zhang, Jason Surratt, Avram Gold, *University of North Carolina at Chapel Hill*

2-Methyltetrols and a group of $C_5H_{10}O_3$ isomers referred to as "alkene triols," are chemical tracers used to estimate the contribution of isoprene oxidation to atmospheric PM2.5. The molecular structures and the mass contribution of alkene triols are uncertain, and their origin as analytical artifacts is contentious. Here, we report that the alkene triols are uptake products and present evidence of partitioning into the gas phase. Based on the hypothesis that rearrangement of IEPOX yields $C_5H_{10}O_3$ isomers on reactive uptake, we synthesized "alkene triol" candidates and investigated their behavior under conventional derivatization gas chromatography/electron impact mass spectrometry (GC/EI-MS) and, in parallel, by non-destructive hydrophilic interaction liquid chromatography coupled with high-resolution quadrupole time-of-flight electrospray mass spectrometry (HILIC/ESI-HR-QTOFMS). Synthetic targets were 3-methyltetrahydrofuran-2,4-diol (**1**) and 3-methylene-1,2,4-trihydroxybutane (**2**).

Using the standards, we confirmed **1** and **2** in chamber-generated cis- and trans-β-IEPOX SOA both by HILIC/ESI-HR-QTOFMS and derivatization GC/EI-MS. In ambient SOA collected in Research Triangle Park, NC, **1** and **2** were confirmed and quantitatively estimated by GC-EI/MS. Trimethylsilyl derivatization of **1** is problematic, yielding predominantly bis- but also a small amount (<10%) of tris-trimethylsilyl forms. Our findings are consistent with reports that the tris-trimethylsilyl derivatives **1** and **2** represent largely thermal decomposition of 2-methyltetrol sulfate esters; however, based on HILIC/ESI-HR-QTOFMS analysis of chamber-generated SOA, we estimate up to 10% and 50% of **1** and **2**, respectively are not artifact-derived, and may arise from isomerization of IEPOX upon reactive uptake. Significant quantities of **1** and **2** were detected in impinger samples downstream from a denuder in series with a filter indicating partitioning into the gas phase. Results suggest that isoprene-derived "alkene triols" do form and are preferentially in the gas phase rather than particle phase, warranting studies on partitioning and gas-phase oxidation pathways.

8AC.5

Secondary Organic Aerosol Formation from Photooxidation of Acyclic Terpenes in an Oxidation Flow Reactor. SHAN GU, Farzaneh Khalaj, Véronique Perraud, Celia Faiola, *University of California, Irvine*

One challenge in predicting secondary organic aerosol (SOA) is an incomplete representation of the chemistry originating from biogenic volatile organic compounds (BVOCs) emitted from plants, particularly those that are emitted in response to plant stressors. For example, plant emissions of acyclic terpenes, such as β-ocimene, β-myrcene, and linalool are commonly induced or present at elevated concentrations under stress conditions (e.g. water stress, ozone stress, and herbivore stress) – conditions that are becoming more frequent in a rapidly changing climate – however, their atmospheric oxidation mechanisms are not well characterized. In this study, SOA formation from the photooxidation of acyclic terpene standards, β-ocimene, β-myrcene, and linalool were investigated in an oxidation flow reactor (OFR). Gas-phase BVOC concentrations were measured using cartridge sampling and off-line analysis with a thermo-desorption gas chromatograph mass spectrometer (TD-GC-MS). Particle size distributions were monitored continuously via a custom-built scanning mobility particle sizer (SMPS). In addition, SOA chemical composition was characterized using an ultra-high performance liquid chromatography coupled to a heated electrospray ionization source and a high-resolution Q Exactive Plus Orbitrap mass analyzer (UPLC-HESI-HRMS). SOA yields were measured as a function of OH exposure and condensed organic aerosol mass. SOA composition of each acyclic terpene system was compared with α-pinene SOA. Results demonstrate that acyclic terpene chemistry is dominated by fragmentation reactions at a lower OH exposure than α-pinene. Further, the SOA yield is more sensitive to changes in OH exposure compared to α-pinene. The observed SOA yield at 10 µg/m3 condensed mass loading was highest for α-pinene (~20%), followed by β-myrcene (~16%), β-ocimene (~8%), and linalool (~5%). This study provides critical information on the oxidation of stress-related plant emissions and their impact on SOA formation in a changing climate.

8AC.6

Cl Oxidation in Chamber and Flow Reactors: SOA Formation, Composition, and Gas Phase Chemistry. NIRVAN BHATTACHARYYA, Pearl Abue, Leif Jahn, Kristi McPherson, Eunha Kang, William Brune, Pawel K. Misztal, Anita Avery, Andrew Lambe, Lea Hildebrandt Ruiz, *University of Texas at Austin*

Chlorine radicals (Cl) are an important atmospheric oxidant in marine, arctic, and polluted urban and industrial regions. Secondary organic aerosol (SOA) formation from VOC + Cl oxidation is often assessed in environmental chamber (EC) experiments, but the chlorine oxidative flow reactor (Cl-OFR) provides an alternative with lower operation costs and increased portability. Due to reduced residence times and higher oxidant concentrations in the OFR, the oxidation chemistry and microphysics may differ from ECs.

In this study, we investigated SOA formation and gas phase products from Cl oxidation of m-xylene, ethylbenzene, limonene, isoprene, and decamethylcyclopentasiloxane in parallel and sequential EC and Cl-OFR experiments. At the beginning and end of EC experiments, chamber air was introduced into the OFR and oxidized over Cl exposures ranging from 10^9 – 10^{11} molecules cm^{-3} s. Oxidation products were analyzed with an Aerosol Chemical Speciation Monitor, a Scanning Electrical Mobility System, an iodide mode Chemical Ionization Mass Spectrometer and Filter Inlet for Gases and Aerosols, and a Vocus Proton Transfer Reaction Mass Spectrometer.

SOA yields were generally similar across EC and Cl-OFR experiments. Organic fractions at *m/z* 43 and 44 ($f_{43/44}$) suggest higher SOA oxidation in the Cl-OFR compared to the EC at similar Cl exposures. Sequential oxidation of limonene and isoprene derived EC SOA in the Cl-OFR generated additional SOA with a similar oxidation state to SOA from the EC alone. This sequential EC/Cl-OFR SOA was less oxidized than SOA only oxidized in the Cl-OFR, suggesting that continued oxidation of the reaction product mixture generates different products than fresh multigenerational oxidation. Gas phase product distributions show reduced Cl-OFR formation of early reaction products in m-xylene experiments related to differences in radical exposures and multigenerational chemistry. While EC and Cl-OFR SOA yields are largely similar, there is evidence for substantial differences in chemistry.

8AC.7

Atmospheric Nucleation Potential Model for Complex Mixtures. Jack Johnson, Dominic Casalnuovo, Darren Cheng, COTY JEN, *Carnegie Mellon University*

Observations over the last decade have demonstrated that the atmosphere contains potentially hundreds of compounds that can react with sulfuric acid to nucleate stable aerosol particles. Consequently, modeling atmospheric nucleation requires detailed knowledge of nucleation reaction kinetics and spatially and temporally resolved measurements of numerous precursor compounds. Achieving these detailed measurements and incorporating their reaction kinetics into an aerosol microphysics model is challenging due to experimental limitations in exploring the entire nucleation reaction compound space and quantifying it in a simple nucleation model. This study presents the Nucleation Potential Model (NPM), a novel nucleation model that dramatically simplifies the diverse reactions between sulfuric acid and any combination of precursor gases. NPM predicted 1-nm nucleation rates are dependent on only two measurable gas concentrations, regardless of whether all precursor gases are known. NPM describes sulfuric acid nucleating with a parameterized base compound at an effective base concentration, [Beff]. [Beff] captures the ability of a compound or mixture to form stable clusters with sulfuric acid and is estimated from measured 1-nm particle concentrations. NPM is applied to experimental measurements of mixtures containing numerous atmospherically relevant compounds that could nucleate sulfuric acid to demonstrate how [Beff] varies for different mixture compositions. In addition, NPM is leveraged to estimate nucleation precursor concentrations from measured concentrations of 1-nm particles. NPM is a valuable tool that will enable more widespread measurements of nucleation precursors and a simple model to predict nucleation rates across diverse environments.

8CO.1 (Invited)

Modeling Coagulation, Aggregation and Gelation in High Volume Fraction Aerosols using Langevin Dynamics Simulations. RANGANATHAN GOPALAKRISHNAN, Zhibo Liu, Vikram Suresh, Zachary Perry, *The University of Memphis*

Effect of volume-fraction and particle-particle hydrodynamic interactions influence particle coagulation in aerosols. Especially, at particle volume fractions exceeding 0.001%, runaway aggregation leads to aerosol gel formation as discovered experimentally (Dhaubhadel, R., et al. (2009). "Light Scattering Study of Aggregation Kinetics in Dense, Gelling Aerosols." Aerosol Science and Technology 43(11): 1053-1063).

In the first part of the presentation, a modeling study that uses Langevin Dynamics (LD) trajectory simulations of N mono-sized spherical particles in a periodic domain is discussed. The extended Kirkwood-Risemann approach (J. Fluid Mechanics 855, 535 (2018)) is invoked to compute particle-particle hydrodynamic interactions whose effect is parameterized as a function of the momentum Knudsen number (Kn). The results are summarized as a model for coagulation rate constant (β_{ij}) that depends on the diffusive Knudsen number (Kn_D) used in prior work to parameterize coagulation in the dilute regime (Aerosol Sci. Tech. 45, 1499 (2011)), Kn and particle volume-fraction η_v. In the absence of hydrodynamic interactions, it is observed that the coagulation rate constant in the continuum limit for mass transfer ($Kn_D \rightarrow 0$) is significantly enhanced by a factor of ~80 at η_v~0.3 due to particle crowding. While considering hydrodynamic interactions for $\eta_v \geq 0.05$, we use a screening distance around each particle that scales inversely with η_v beyond which the contribution of farther neighbors is neglected owing to the rapid decay of hydrodynamic interactions with distance. We also present new LD calculations of β_{ij} and elucidate the dependence of the same on Kn_1 and the particle radii ratio θ_r for the coagulation of two particles in the dilute limit $\eta_v \rightarrow 0$. It is observed that the reduction of β_{ij} becomes significant as $Kn_1 \rightarrow 0$: at the lowest momentum Knudsen number considered ($Kn_1=0.1$): β_{ij} is reduced by a factor of ~10 for equally sized particles ($\theta_r=0.5$). At high Kn_D,Kn_1, the particle size disparity is not significant, and it is seen that β_{ij} matches hard sphere predictions, indicating the insignificant contributions by hydrodynamic interactions. This study was recently published in in the J. Aerosol Science (https://doi.org/10.1016/j.jaerosci.2022.106001) and includes a series of animations of 2-particle simulations to illustrate the role of hydrodynamic interactions in particle coagulation. Computational results are summarized as regressions for convenient incorporation into particle/droplet growth sectional models.

In the second part of the presentation, current work that is yet to be published on modeling aggregation and gelation is discussed. Starting with *N* monomers, a Langevin Dynamics simulation that tracks particle aggregation until all the monomers are part of a single super-aggregate. Predictions of aerosol gel structure and morphology, their adhesion energy/strength are developed for comparison with appropriate experimental data. Secondary effects such as agglomerate rotational motion as well as translation-rotation coupling are discussed. Also presented is a modeling approach in the works to capture particle sticking and subsequent agglomeration without ad hoc assumptions. Considerations of experiment design are presented to enable model refinement.

8CO.2

Analysis of Nascent Soot Particles from Acetylene Pyrolysis: A Molecular Modeling Perspective. KHALED MOSHARRAF MUKUT, Anindya Ganguly, Eirini Goudeli, Somesh Roy, *Marquette University*

Soot or black carbons are combustion-generated carbonaceous nanoparticles formed during incomplete combustion of hydrocarbon fuels. Due to the complexity of hydrocarbon combustion systems, there exists a considerable knowledge gap in the fundamental processes and properties of soot as they form and evolve during combustion. This study uses reactive molecular dynamics simulations with reactive force field (ReaxFF) potentials to address this knowledge gap. The focus of the current work is the formation and evolution of soot during acetylene pyrolysis at different temperatures. One thousand acetylene molecules are allowed to collide and react at four different temperatures from 1350 K to 1800 K. The analysis provides insights into physicochemical aspects of soot formation as well as the maturation of incipient soot particles at different temperatures. The chemical evolution of the acetylene systems points to a boundary between gas-phase and potential particle-phase indicated by a steady decrease of smaller hydrocarbons, followed by a spike in C_6-C_{10} molecules and the eventual formation of a cluster with more than 30 carbon atoms, which morphs into a soot particle. Once a soot particle is formed, we focus on the evolution and interdependence of features such as the number of carbon atoms, number of aromatic rings, mass, C/H ratio, the radius of gyration, fractal dimension, surface area, volume, fringe spacing distribution, and density. The soot particles, irrespective of process temperature, become more spherical and more compact with time, while the C/H ratio converges to a value around 2.5. Qualitative correlations of various degrees are also observed between some of these morphological features. This study is expected to provide important insights into the pathways of soot formation and help develop more accurate engineering-scale models for soot formation in combustion simulations.

8CO.3

High-throughput Generation of Aircraft-like Soot. GEORGIOS A. KELESIDIS, Una Trivanovic, Sotiris Pratsinis, *ETH Zurich, Switzerland*

High-throughput, laboratory units for generation of aircraft-like soot are needed to quantify and understand the impact of such emissions on public health and climate change due to the high costs and limited access to aircraft engines. Flame spray pyrolysis [1] is used here to generate high soot concentrations, up to 255 mg/m^3, three orders of magnitude higher than those typically obtained by widely-used soot generators, such as premixed flame reactors [2]. This enables routine characterization of the soot specific surface area (SSA) and pore size distribution by N_2 adsorption. The geometric mean mobility diameter, d_m, of soot agglomerates was systematically varied from 15 to 180 nm by varying the equivalence ratio (EQR) at constant fuel feed rate. The geometric mean primary particle diameter, d_p, standard deviation, σ_{gp}, and mass-mobility exponent, D_{fm}, were hardly altered in that EQR range. These measured D_{fm} and σ_{gp} indicate that soot primary particles were sinter-bonded by surface growth [3], in agreement with power laws derived by discrete element modeling [4]. The organic to total carbon mass ratio of soot produced here is consistently small (< 20%) regardless of EQR. Most importantly, soot made at EQR ≤ 1.34 has mainly small pores (< 2.5 nm) and similar morphology (D_{fm}= 2.52 ± 0.17), SSA (160 - 239 m^2/g), d_m (15 - 60 nm) and d_p (14 nm) with those from high thrust aircraft emissions.

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8CO.4

Investigating the Effects of the Air-to-Fuel Ratio and Fuel Type on the Formation of Environmentally Persistent Free Radicals in Combustion Particles. DESIREE SARMIENTO, Brian Majestic, *University of Denver*

Environmentally persistent free radicals (EPFRs) are a newly identified class of environmental risk substances that have adverse effects on the environment and human health. The main source of EPFRs is the incomplete combustion of hydrocarbon fuel, wherein the free radicals that are formed become stabilized on the surface or within the structures of soot particles. This stabilization allows these radicals to persist in the environment for several months to a few years, which gives EPFRs an opportunity to contaminate various environmental matrices or react with other species in the atmosphere. These reactions involving EPFRs can form reactive oxygen species (ROS) and secondary EPFRs, which have importance in both biological and environmental systems. Internal combustion engines operate on different types of fuels and at various air-to-fuel (A/F) ratios depending on the motor vehicle and engine load. The fuel type and A/F ratio can influence EPFR formation from the resulting combustion reaction. In this study, soot particles were produced from the combustion of hexanes at various A/F ratios, and the EPFRs formed in each soot sample were quantitatively determined by electron paramagnetic resonance (EPR) spectroscopy. From these reactions, lower EPFR formation was generally found in soot samples produced from higher A/F ratios, and a strong negative correlation ($R^2 = 0.971$) was observed between the average number of EPFRs and the A/F ratio. Further investigation involving the A/F ratio will be conducted on soot formed from the combustion of different types of fuel to examine the effects of various fuel additives on EPFR formation.

8CO.5

Ions Generated from a Premixed Methane-air Flame: Mobility Size Distributions and Charging Characteristics. CHANAKYA BAGYA RAMESH, Yang Wang, *Missouri University of Science and Technology*

Chemical ionization in combustion systems forms concentrated ions of both polarities. Applying electric fields and plasmas to combustion systems has been shown to reduce emissions (such as particulate matter) potentially through controlling the ionic properties. Detailed flame-generated ion properties need to be characterized to better understand and predict the dynamics and roles of these ions in combustion and particle formation processes. In this work, we used a high-resolution differential mobility analyzer (HR-DMA) to map the mobility and size distributions of positive and negative ions generated from a premixed methane-air flat flame under atmospheric pressure with a McKenna burner and a stainless-steel tube burner. Measurements were conducted over a wide range of stoichiometric ratios (0.8 to 1.2) and heights above the burner (2 to 22 mm). Positively charged ions are relatively stable over the entire range of experimental conditions for both burners, showing two major modes at 1.2 and 1.5 nm. Negatively charged ions, however, were only detectable within 12 mm above the burner for stainless-steel tube burner, and the peak diameters were approximately 1 and 1.3 nm. The absence of negative ions at higher heights is likely due to their transformation into electrons rather than recombination with positive ions since there was no sudden change in positive ion concentrations. For McKenna burner, negatively charged ions were detectable even at a height of 22mm above the burner. With the mobility values of the ions, we calculated their approximate mass values based on the empirical mobility-mass relationship and estimated the charging characteristics of particles in the flame. The ion profiles and particle charging characteristics obtained in this study will improve our understanding of the electrostatic interactions in flame systems.

8CO.6

Modeling Characterization of Smoke Particle Transport and Fate in Lunar Gravity. CLAIRE FORTENBERRY, David Urban, Gary Ruff, *NASA Glenn Research Center*

Spacecraft fires present one of the most dangerous scenarios threatening crew safety for future lunar and deep space missions. Optimal spacecraft fire detector placement strategies are challenged by transport phenomena unique to reduced gravity environments. Studies of spacecraft fire detection conducted to date have focused on microgravity systems, but, as NASA plans to return to the Moon, more research is needed to evaluate optimal detector placement in lunar gravity. Chiefly, improved knowledge of plume transport in lunar gravity is needed; unlike in microgravity, some buoyant plume flow is expected, though transport timescales remain unclear. Furthermore, previous research has demonstrated that spacecraft life support system properties, particularly high cabin filtration rates, lengthen times to alarm. The optimal detector placement in a lunar habitat will involve a balance between these two factors.

We present computational results on smoke particle transport in lunar gravity. This model combines turbulent flow, heat transport, and particle transport from a simulated fuel overheating (pre-flame) scenario under varied maximum temperature and fuel configuration conditions. Particle velocities are mapped in lunar gravity and compared to results from micro- and terrestrial gravity to evaluate timescales for buoyant transport. Additionally, forced air flow is introduced to mimic a hypothetical scenario with cabin air supplies on the ceiling and returns on the floor. Results suggest that in lunar gravity, smoke particles travel upward at velocities similar in magnitude to average air velocities on the ISS. This upward flow may enable strategic placement of smoke detectors on ceilings of future lunar spacecraft cabins, depending on the cabin ventilation velocity, air filtering characteristics, and habitat design.

8IA.1

Long-term Indoor-outdoor PM2.5 Measurements at Three California Sites. LANCE WALLACE, Wayne Ott, *Stanford University*

Indoor and outdoor PM2.5 measurements using low-cost PurpleAir monitors were made over extensive periods at three California homes. One objective was to compare a recently-developed algorithm for calculating PM2.5 to the proprietary algorithm used by the Plantower company that manufactures the sensors employed in the PurpleAir monitors. A second objective was to calculate and compare PM2.5 produced by indoor activities with PM2.5 due to particles of outdoor origin. The new algorithm (called ALT-CF3 and now available on the PurpleAir API) had better precision, lower limit of detection (LOD), and many more values above the LOD than the Plantower proprietary algorithms (CF1 and CF_ATM). At the low indoor PM2.5 levels found in many homes, this could result in the loss of more than half of all the indoor air data collected. The second objective of calculating PM2.5 concentrations due to indoor activities was approached by using the Random Component Superposition (RCS) model developed by Ott et al (2000). This regression model assumes a constant infiltration factor. If the assumption is correct, a line through the origin with the same slope as the regression defines a “forbidden zone” below the line where few observations should be found. This is a self-correcting feature, because if many observations lie in the forbidden zone, the assumption of a constant infiltration factor is violated. Then a search for a subset of values with a constant infiltration factor can sometimes identify such a subset and calculate the indoor-generated PM2.5. Our results for three homes identified indoor-generated PM2.5 meeting the forbidden-zone requirements for at least three seasons in all cases.

8IA.2

Cleaning the Indoor Air with Low-Cost DIY Air Cleaners.

Nirmala Thomas Myers, Taewon Han, Kevin Dillon, GEDIMINAS MAINELIS, *Rutgers, The State University of New Jersey*

The do-it-yourself (DIY) air cleaners offer an easy and cost-effective way to remove particles, bioaerosols, and their agglomerates from indoor air. Our study evaluated the particle removal efficiency and clean air delivery rate (CADR) of DIY air cleaners with a 20 x 20-inch box fan and commercially-available filters (Filterbuy Inc., Talladega, AL, USA) of 1-inch, 2-inch, and 4-inch thickness with MERV rating ranging from 6 to 14. The selection criteria were total costs of < \$50 for a single-filter DIY air cleaner and < \$100 for a multi-filter DIY air cleaner. The filtration efficiency testing was performed with 10% NaCl liquid suspension aerosolized at 10 L/min (19 psi) using a 6-jet Collison nebulizer (CH Technologies, Westwood, NJ, USA), yielding a 10 nm – 10 µm particle size range and 150-200 µg/m^3 mass concentration. Experiments were performed in a classroom modified to be a large test chamber (85 m^3). The particle mass and number concentrations, including size distribution, of the produced aerosol were measured using a DRX (TSI Inc., Shoreview, MN, USA) and the Mini Wide-Range Aerosol Spectrometer (Grimm Inc., Aerosol Technik GmbH & Co. KG, Ainring, Germany). The box fan's sound levels and heating were also monitored. The results show that DIY air cleaners can achieve CADR of 200 cfm or higher with a proper filter selection. The CADR values were similar to those of commercial HEPA air cleaners costing up to 10x higher. The CADR values were the highest for MERV 13 filters compared to MERV 8 and MERV 11 filters. In addition, MERV 13 4-inch single-filter models performed superior to the 2-inch and 1-inch single-filter models with the same MERV rating. This study demonstrates the utility of low-cost DIY filters in improving indoor air quality. The results will help DIY enthusiasts to pick the best fan-filter combination to mitigate exposures to indoor particles, including infectious aerosols such as SARS-CoV-2 and other viruses.

8IA.3

A Field Study to Characterize Human Emissions in Indoor Air.

CHETHANI ATHUKORALA, Suresh Dhaniyala, *Clarkson University*

In light of the on-going COVID-19 pandemic, there has been an interest in understanding generation, transport, and fate of particles from human emissions. In indoor environment, human-based particle emissions are primarily from breathing and talking. Several research studies have established the characteristics of particle emissions from human activities under controlled lab conditions. Such lab tests use a limited range of air properties, speech phrases, etc. In the real-world, due to the diversity of human speech patterns, ventilation conditions, particle interaction with the surroundings, etc. the effective emission characteristics could be very different from that measured in the lab. To characterize real-world effective human emissions and their contribution to indoor particle transmission, we conducted an experimental study to monitor airborne particles in a highly used, large classroom for a period of 5 months. The temporal change in particle size distributions was determined from measurements made using an Ultra-High Sensitivity Aerosol Spectrometer (UHSAS; DMT, CO; size range: 70 nm – 0.5 µm) and an Aerodynamic Particle Sizer (APS; TSI, MN; size range 0.5 µm – 20 µm). Spatial variation in the concentration of measurements were taken from a network of low-cost optical sensors deployed throughout the room. The measurements were made over a period spanning a change in masking policy from required to optional. Combining the measurement data with an indoor flux-balance model, we obtain one of the first data sets of real-world human emission characteristics that can constrain future efforts to model indoor transmission of airborne diseases.

8IA.4

Using a Network of Low-Cost Sensors to Characterize Seasonal, Building, and Occupancy Patterns in Indoor Air Quality Across a University Campus. SABRINA WESTGATE, Nga Lee Ng, *Georgia Institute of Technology*

Although we spend the majority of our time indoors, the wide array of distinct indoor environments makes it difficult to understand indoor air quality (IAQ) in an individual indoor space. Considering that IAQ plays a significant role in cognition performance and learning, it is particularly important to quantify and evaluate IAQ in classrooms. To assess IAQ in a university setting, low-cost sensors (QuantAQ MODULAIR and MODULAIR-PM) with the capability to detect particulate matter (PM_1, $PM_{2.5}$, PM_{10}), CO_2, CO, NO_x, O_3, temperature, relative humidity, and pressure were installed across the Georgia Institute of Technology campus beginning in Fall 2020. While previous studies have examined IAQ trends in classrooms, to our knowledge this is the first study to do so for both an extended period of time (>1 year) and among such a large number of buildings (>20) in the same university and geographic location. In this study, monitoring the IAQ in multiple buildings on one campus provided a valuable opportunity to investigate the most important parameters that impact IAQ of various rooms and buildings. To characterize IAQ, PM concentration changes during room occupancy, room ventilation rate, and indoor/outdoor PM ratios were quantified. Receptor modelling on the sensor data was also explored to identify and compare indoor air pollutant sources. While analyzing the indoor air data, principal component analysis was performed to identify the impact and relative contribution of factors including room size, room materials, room location, room ventilation type, building age, and occupant activities upon IAQ trends were considered. Our results indicate that seasonality, ventilation type, and occupant activities play a large role in influencing IAQ patterns. Moreover, a case study involving the addition of portable air cleaners to a subset of the rooms highlighted the importance of occupant behavior on IAQ patterns and pollution mitigation strategies.

8IA.5

Using Low-cost Sensors to Assess the Impact of Outdoor Air Pollution on Indoor Air Quality of Buildings with Intake of 100% Ambient Air. DANIEL ALVARADO-VELEZ, Sabrina Westgate, Eben Cross, David Hagan, Nga Lee Ng, *Georgia Institute of Technology*

People spend most of their time in indoor environments, in which outdoor pollution is among one of multiple factors that determine indoor air quality (IAQ). Some factors that affect indoor pollution are ventilation rate, indoor sources of pollutants, indoor air chemistry, and building age, among others. Due to the expensive nature of continuously monitoring air quality using high grade research instruments, low-cost sensors are increasingly used in IAQ studies. In this study, we utilized paired QuantAQ MODULAIR and MODULAIR-PM sensors to measure the mass concentration of particulate matter (PM) of different sizes (PM1, PM2.5, PM10) and the mixing ratio of CO2, CO, NO, NO2, and O3 inside and outside two buildings on Georgia Tech campus. These two buildings are of different ages but both use 100% ambient air in ventilation. Measurements were conducted from Fall 2021 to Spring 2022. Results indicate that the indoor PM mass concentration generally follows a similar trend to the outdoor PM mass concentration, with R2 of 0.50 – 0.67, 0.49 – 0.62, and 0.34 – 0.60 for PM1, PM2.5, PM10, respectively. The contribution of outdoor PM concentration to indoor PM concentration varies by room. The highest observed contribution of outdoor PM1 concentration to indoor PM1 concentration was approximately 60%. Gas-phase pollutants did not show a good correlation between indoor and outdoor concentrations. This is thought to be because the gases studied are more affected by indoor sources and/or can react with other pollutant species. The indoor pollutants also show different trends depending on the day of the week, highlighting the contribution from specific sources. Results from this study provide insights into the extent to which IAQ is impacted by outdoor air and will help in determining improvements needed in building designs for better IAQ.

8IA.6

Residential Radon Measurements in Puerto Rico. LUPITA MONTOYA, Marc Menetrez, Jacky Rosati Rowe, Pedro Tarafa, *US Environmental Protection Agency*

Radon was ranked the fifth leading cause of mortality by the World Health Organization in 2010. In the US, radon is the number one cause of lung cancer for non-smokers. In the 1990's the Environmental Protection Agency (EPA) completed a series of Radon Zone Maps by measuring radon throughout the continental US, Alaska, and Hawaii; however, this effort did not include US territories such as Puerto Rico. In a separate study, the US Geological Survey (USGS) found that several areas in Puerto Rico have the geologic potential to generate indoor radon levels exceeding the EPA action level of 4 picocuries per liter (pCi/L) of air. A recent collaboration between the EPA and the University of Puerto Rico at Mayagüez (UPRM), seeks to produce the first residential radon map for Puerto Rico. The project is implementing the New Testing Method for Community Mapping of Radon, which employs the Corentium Home (CH) radon detection device by Airthings (Airthings Inc, 2021). The devices were used in seven initial target municipalities, located in the northwest part of the island. Information on individual homes is kept in privacy, while regional data are used for radon mapping and eventual transmittal to Puerto Rican health authorities, informing potential development of land-use planning and building code recommendations. This talk will present the results of preliminary radon measurements in this ongoing study.

8IA.7

Estimating Air Exchange Rate using Concentration Time Series Data based on Unsupervised Learning. Bowen Du, JEFFREY SIEGEL, *University of Toronto*

Air exchange rate affects indoor air quality and building energy consumption. This building parameter is highly variable due to the variations of weather and building operation, while conventional tracer gas methods only provide a snapshot of the building ventilation condition as they are intrusive and time-consuming, leaving a critical knowledge gap in the long-term air exchange rate of buildings of different types. In this study, we used an unsupervised machine learning model to automatically recognize decay trends from pollutant concentration time series and estimate building air exchange rate based on mass balance. The model uses k-means clustering for extracting decay periods and then density-based spatial clustering of applications with noise (DBSCAN) for grouping them. We tested the feasibility and generalizability of the model on multiple datasets collected from various university and residential environments. Results suggested that the proposed model can recognize several decay episodes per day based on CO_2 and $PM_{2.5}$ concentration data. The estimated decay rate of CO_2 is consistently lower than that of $PM_{2.5}$ as the former is a proxy of air exchange rate while the latter is a proxy of effective air exchange rate including deposition and potential filtration. Further, the decay rate of both varies spatially and temporally. The impact of clustering hyperparameters, baseline concentrations, sensor accuracy, and result filtration on the estimated air exchange rate is discussed in detail to develop a protocol for selecting the optimal model parameters and ensuring reproducibility. Overall, the proposed model provides a low-cost solution to monitoring long-term air exchange rate, which also has potentially wide applications including assessing air mixing conditions and characterizing the emitting profile of indoor air pollution sources.

8ID.1

Fitted Facemask Containment: Importance for Determining Transmission of Virus-Laden Aerosols. WILLIAM BENNETT, Steven Prince, Kirby Zeman, James Samet, *University of North Carolina at Chapel Hill*

Background: Facemasks reduce transmission of viruses by 1) protecting the wearer from virus-laden aerosols in the environment and 2) reducing aerosol emissions to the environment from infected individuals. Methods quantifying fitted filtration efficiency for wearer protection (PE) are well established (e.g., Sickbert-Bennett et al. JAMA Intern Med. 2020;180(12):1607). But current methods for assessing facemask containment efficiency (CE) in human subjects rely on measuring a low concentration of aerosols emitted from an infected or healthy individual.

Methods: Expanding on methods used for measuring PE, we designed a small-volume, low-ventilation chamber to accommodate a seated adult male subject. A ported facemask (N95, KN95, Procedure, or Gaiter) enabled introduction of a stream of 0.05um NaCl particles at a constant concentration behind the mask. Ambient chamber concentration was continuously measured by a condensation particle counter sampling 2 feet in front of the face over a series of three 3-minute periods: 1) resting, 2) reading out loud, and 3) repeated forceful coughing. %CE for each mask/procedure was determined as 100*(1 - average of ambient concentration values 30-180 seconds/the same for a “no mask” condition). PE was also measured in the same chamber by referenced/published methods. %Transmission from infected to uninfected is a function of both %CE and %PE = {1-(CE/100)}*{1-(PE/100)} *100.

Results: The average %CE for each mask over all procedures and repeat measures were 94.6, 60.9, 38.8, and 43.2 respectively, for masks listed above. The %PE for each mask was 99.2, 58.9, 30.8, and 6.5. Based on these calculations, %transmission for a KN95 worn by both infected and uninfected is approximately 16% compared to 40% when there is only one wearer.

Conclusion: The best DOUBLE masking for reducing aerosol transmission of virus is two mask wearers.

UNC/USEPA Cooperative Agreement CR83578501.

8ID.2

Filtration Efficiencies of FFP2 and Surgical Masks After Their Regeneration Using Methods Available in Common Households. RICARDO TISCHENDORF, Hans-Joachim Schmid, *University of Paderborn, Germany*

During the SARS-CoV-2 pandemic, wearing medical masks in public was often prescribed by policy mandates. Thus, both, FFP2 and surgical masks have been frequently used in 2020 and 2021 worldwide, and people regenerated their masks using techniques that can be found at home (by dry thermal treatment within an oven, or by wet soapy water submersion within washing machines). In the last years, the knowledge about the consequences of those treatments for the Filtration Efficiencies (FEs) of FFP2 mask types was acquired. However, studies focusing on the investigation of the surgical masks FEs in the sub-micron size range are still rare. Hence, we characterized and compared the FEs of FFP2 and surgical masks experimentally before and after their regeneration by two household techniques. Both mask types were characterized by means of an uniform and stabilized teat aerosol, allowing a direct comparison of the derived FE values. For reference, FEs were additionally determined after depolarizing the masks by Isopropanol (IPA) soaking, and the mask performances were compared to commercially available cloth masks.

It was shown, that soapy water submersion influences the FEs of all medicinal masks most critically. The corresponding FE values reduce down to the values of IPA soaking, indicating the masks fibers electrostatic charge loss. However, interestingly, most treated FFP2 masks have still higher FEs in comparison to fresh surgical masks and obviously, utilizing regenerated FFP2 masks instead of fresh surgical masks is clearly better from the filtration point of view. This finding is especially relevant since both medical mask types are treated similarly in several policy mandates (e.g. in Germany 2021/22) and the utilization of recycled FFP2 masks instead of fresh surgical masks would be associated with an increased public protection level.

8ID.3

Survival of Aerosolized SARS-CoV-2 on Masks. JIN PAN, Aaron Prussin II, Seth Hawks, Nisha Duggal, Linsey Marr, *Virginia Tech*

The potential for masks to act as fomites in the transmission of SARS-CoV-2 in real-world situations is not well understood. In theory, a person could touch a contaminated mask and transfer virus to their mucus membranes, but for infection to occur, the virus must maintain infectivity while on the mask, among other steps in the process. Several studies have evaluated the persistence of SARS-CoV-2 on different types of masks, but the methods relied on inoculating the surface with unrealistically large droplets containing the virus. Under such conditions, survival of SARS-CoV-2 may be prolonged, and hence the potential for fomite transmission may be exaggerated. In this study, we contaminated the masks in a more realistic way: we aerosolized a suspension of SARS-CoV-2 in saliva at a realistic titer and used a vacuum pump to pull the aerosol through six different types of masks. SARS-CoV-2 lost all detectable infectivity within an hour at 28°C, 80% RH on an N95, surgical mask, polyester mask, and two different cotton masks. The virus was still viable on a nylon/spandex mask. SARS-CoV-2 RNA remained stable for an hour on most of the masks. Differences in particle collection efficiency and elution efficiency among the masks influenced the results. The potential for masks contaminated with SARS-CoV-2 aerosols to act as fomites appears to be less than indicated by studies involving inocula with very large droplets.

8ID.4

Ventilation, Air Filtration and Universal Masking to Reduce Exposure to Respiratory Aerosols in a Simulated Classroom. WILLIAM LINDSLEY, Raymond Derk, Jayme Coyle, Francoise Blachere, Stephen Martin, Jr., Kenneth R. Mead, Donald Beezhold, John Noti, *National Institute for Occupational Safety and Health*

SARS-CoV-2 can be spread by aerosols expelled by infected people when they cough, talk, sing, or exhale. Exposure to these aerosols while indoors can be reduced by increasing ventilation rates, using portable air cleaners, and wearing face masks. To study the effectiveness of these interventions singly and in combination with each other, we placed a NIOSH respiratory aerosol source simulator in a conference room to simulate a person who was exhaling infectious aerosols. We then placed a breathing simulator 6 feet (1.8 m) in front of the source simulator to represent a speaker such as a teacher exposed to these respiratory aerosols, and placed two breath simulators 3 feet (0.9 m) and 6 feet (1.8 m) to either side of the source simulator to simulate other participants such as fellow students who also were potentially exposed to these aerosols. Aerosol concentrations were measured at the mouths of the speaker and participants to determine their aerosol exposure. We found that increasing the room ventilation rate from 2 air changes/hour (ACH) to 6 ACH reduced the aerosol exposure of the speaker and participants by an average of 37%, while adding two portable HEPA air cleaners in the center of the room with a combined filtration rate of 5 ACH reduced the average exposure by 65%. Placing cloth face masks on all the simulators reduced the average exposure by 72%. A combination of increasing ventilation from 2 ACH to 6 ACH and universal masking reduced exposure by 87%, while combining universal masking with the HEPA air cleaners reduced exposure by 90%. Our results show that increased ventilation, portable air cleaners, and universal masking can all reduce exposure to indoor respiratory aerosols, and that a combination of these methods is more effective than any single intervention.

8ID.5

Ventilation and COVID-19 Risk Reduction. V. FAYE MCNEILL, Richard Corsi, J. Alex Huffman, Cathleen King, Robert Klein, Michael Lamore, Shelly L. Miller, Nga Lee Ng, Paula Olsiewski, Krystal Godri Pollitt, Rachel Segalman, Alex Sessions, Todd Squires, Sabrina Westgate, *Columbia University*

Layered risk reduction is an effective approach for reducing transmission of airborne pathogens including SARS-CoV-2. Such an approach may include adequate ventilation, air filtration, indoor air quality monitoring, and masks. Long-term investment in interventions which contribute to a healthy environment but rely less on personal responsibility, such as ventilation, filtration and IAQ monitoring, is desirable. Besides reduction in the transmission risk for SARS-CoV-2 and other pathogens, these interventions will lead to improved indoor air quality, with health co-benefits.

We will discuss these points and present data from experiences where we partnered with facilities managers to characterize ventilation and to mitigate issues where they were identified. We will present an overview of approaches for measuring air exchange along with their advantages and disadvantages. We will share results from various building ages, types, locations, and climates, highlighting their commonalities and differences, and discuss best practices.

8ID.6

Application of Portable Air Cleaners to Control the Presence of SARS-CoV-2 Aerosols in Homes of COVID-19 Infected Adults. GEDIMINAS MAINELIS, Nirmala Thomas Myers, Robert Laumbach, Kathleen Black, Pamela Ohman-Strickland, Shahnaz Alimokhtari-V, Alicia Legard, Adriana De Resende, Leonardo Calderón, Frederic T. Lu, Howard Kippen, *Rutgers, The State University of New Jersey*

Individuals with COVID-19 who do not require hospitalization are instructed to self-isolate in their residences. To minimize the secondary attack rates of COVID-19 among household contacts, there is a need to understand the airborne transmission of SARS-CoV-2 within residences. We report on the first naturalistic intervention study to investigate a reduction of such transmission risk using portable air cleaners (PACs) with HEPA filters.

Subjects with confirmed COVID-19 were recruited in the fall/winter of 2020-2021. The PAC was placed in the primary room, where the infected individual was self-isolating. In one 24-hr period, the PAC was operated with a HEPA filter and during the other without a filter ("sham" period), in a randomized order. 24-hr air samples of total aerosols were collected in the primary room and the common room on PTFE filters using open-face filter holders at 10 L/min. Samples were analyzed by RT-PCR for expression of three distinct SARS-CoV-2 genes: N, ORF1ab, and S. Samples were considered positive if any one gene and internal control (MS2 phage) were detected at Ct ≤ 40.

Seventeen individuals completed the entire study. Seven out of sixteen (44%) air samples in primary rooms were positive for SARS-CoV-2 RNA during the sham period. With the PAC operated at its lowest setting (CADR = 263) to minimize noise, positive aerosol samples decreased to four out of sixteen residences (25%) (p=0.229). In addition, a slight decrease in positive aerosol samples was observed in the secondary room.

Thus, our results show that SARS-CoV-2 RNA is common in the home air of COVID-19 patients. As the world confronts both new variants and variability in vaccination rates, our study supports this practical intervention to reduce the presence of viral aerosols in a real-world setting.

8ID.7

Evaluation of Secondary Chemistry due to Disinfection of Indoor Air with Germicidal Ultraviolet Lamps.

ZHE PENG, Shelly L. Miller, Jose-Luis Jimenez, *University of Colorado Boulder*

The disinfection of air using Germicidal Ultraviolet light (GUV) is a long-standing technique, which has received intense attention during the COVID-19 pandemic. GUV generally uses UVC lamps as its light source, which are known to initiate photochemistry in air. However, the impact of GUV on indoor air chemistry has not been investigated in detail, to our knowledge. In this study, we model the chemistry initiated by GUV at 254 or 222 nm (GUV254 or GUV222) in a typical room with poor or reasonable ventilation. GUV254 is irritating to skin and eyes, has an occupational exposure limit to people, and thus these fixtures typically irradiate a small volume near the ceiling. GUV222 is thought to be much less harmful to skin or eyes and can be used for the whole room volume. Results of our analysis showed GUV254 nm can photolyze O3 in significant amounts and efficiently generate OH radicals, which initiates the oxidation of indoor volatile organic compounds (VOCs). Common products of VOC oxidation, e.g., carbonyls and peroxides, can also be directly photolyzed by GUV254, which helps sustain the radical chemistry indoors. Secondary organic aerosol can be formed in µg/m3 and tens of µg/m3 in typical and polluted indoor spaces, respectively, as a product of VOC oxidation, with an estimated bulk VOC mass yield of the order of 1%. In contrast, GUV222 with the same effective virus removal rate makes a smaller impact on indoor air quality, mainly because of substantially less efficient O3 and carbonyl photolysis than GUV254. Increasing air exchange between the irradiated and unirradiated spaces in a room with GUV254 is recommended, since it reduces UV intensity needed to attain a certain virus removal rate and hence the impact on indoor air quality. Better ventilation can not only remove pathogens, but also limit the production of secondary indoor pollutants by GUV, and is thus also recommended when outdoor air is relatively clean.

8IM.1

Development of a DART-HRMS Method to Characterize Chemical Composition of Microplastic Particles.

EMILY HALPERN, Christopher P. West, Alexander Laskin, *Purdue University*

As the global demand for plastic grows, plastic pollution has become more of an environmental concern. Microplastics are released from plastic waste that is left to degrade and it proliferates in the air, organisms, water systems, and soil. To determine the ecotoxicological impact of microplastics, a comprehensive, untargeted method of determining their chemical composition is needed. Here we investigate direct analysis in real-time high-resolution mass spectrometry (DART-HRMS) and pyrolysis DART-HRMS (pyro-DART-HRMS) methodologies as an analytical workflow to study chemical composition of plastic standards and mixed waste plastic. DART allows for ambient and rapid ionization of solid and liquid samples with no sample preparation, while pyro-DART allows for thorough polymer description with high desorption temperatures and temperature-based separation of compounds. Kendrick mass defect analysis is used to simplify the complexity of polymer spectra and identify characteristic CH_2-H_2 fingerprints for plastic types to allow for their distinction in mixed waste. By first analyzing common plastic standards, a spectral library of common plastics was first constructed. This spectral library is then applied for the deconvolution of mixed microplastic samples. Further contaminant identification is facilitated with high-resolution mass spectrometry, which allows for identification of nitrogen, sulfur, and oxygen containing contamination in plastic samples. Chlorine and bromine containing organic species were detected through their characteristic isotope distributions. The analysis of these common organic pollutants allows for assessment of the contamination risk of these microplastic sources. Mixed microplastics contain high amounts of N, O, S, Cl, and Br contamination which increase their pollution potential. This work demonstrates a new analytical method for fast and comprehensive characterization of mixed microplastics.

8IM.2

Calibration of the Aerodyne Aerosol Mass Spectrometer with Total Particulate Nitrogen and Carbon Measurements. ANN M. MIDDLEBROOK, Derek J. Price, Allison Piasecki, Rishabh U. Shah, Katherine L. Hayden, James B. Burkholder, James M. Roberts, *NOAA ESRL CSL*

The Aerodyne Aerosol Mass Spectrometer (AMS) and Aerosol Chemical Speciation Monitor (ACSM) instruments measure the real-time, non-refractory, chemical composition of aerosol particles and have been deployed by a multitude of institutions for ambient air measurements. Typical AMS and ACSM calibrations have relied on other well-calibrated aerosol instrumentation such as differential mobility analyzers with aerosol counting and optical sizing measurements to provide a precisely known mass concentration of aerosol species to compare with the AMS or ACSM instrument response. We have been developing new methods to measure aerosol nitrogen (N) and carbon (C) mass for direct verification of the AMS sensitivity to a variety of species pertinent to the atmosphere. These methods provide aerosol mass calibrations traceable to gas-phase standards: nitric oxide (NO) and carbon dioxide (CO_2). For this study, aerosol particles were generated, dried, size-selected, and then denuded before being introduced to the AMS and a heated platinum/molybdenum catalyst system. The catalysts converted aerosol nitrogen and carbon to NO and CO_2, that were subsequently detected with NO-ozone chemiluminescence and a commercial CO_2 analyzer. Elemental ratios were determined directly from these measurements. We also used a unit-mass-resolution AMS with a light-scattering module to measure the collection efficiency and a high-resolution AMS to distinguish elemental composition for direct comparisons with the catalyst-based conversion technique. Here we will present the results of experiments using aerosols composed of ammonium salts or molecules containing both carbon and nitrogen species.

8IM.3

Activation of Single Aerosol Particles into Droplets with Immediate Capture into an Open Channel Microfluidic Device. WENDY FLORES-BRITO, Thomas Brubaker, Shelley Anna, Ryan Sullivan, *Carnegie Mellon University*

Individual physicochemical analysis of aerosol particles continues to be a challenge since few techniques exist that can preserve an aerosol's individual identity following sampling each particle for further offline analysis. We developed a new method that features direct activation of aerosol particles into aqueous droplets followed by droplet capture into an open channel microfluidic device while potentially maintaining their individual particle–droplet pair identity in an immiscible fluid. As part of the method development, we produced a model using the Stokes and Weber numbers to predict the impaction and coalescence of the single-particle-droplets into a continuous oil phase. The critical controllable variables to optimize droplet-to-oil collection are the droplet diameter and velocity. We collected single-particle-droplets containing fluorescent salt into an immiscible fluid and measured the total fluorescent droplet volume present. The measured and simulated collected fluorescent volume results were directly compared, resulting in an impacted droplet collection efficiency ranging from 41 ± 12% to 140 ± 16%. The upper bound is a worst-case scenario, based on highly conservative approximations, assuming most droplets will not be collected in the immiscible fluid region, thus inflating the impacted droplet collection efficiency. The lower bound is based on approximations from current Weber and Stokes number literature values and is a more realistic representation for the system. Our analysis indicates this new method successfully collects single-particle-droplets into an immiscible fluid while maintaining the individual identity of the particle contained in each droplet. We have started to extend this droplet collection system into a oil that is flowing through the open channel collection region into a serpentine microfluidic channel. This will enable chemical analysis of each particle contained in each droplet such as by optical spectromicroscopy or electrochemical methods. This technique can be applied used in any field that requires knowledge of individual aerosol particle properties (such as virology, aerosol health effects, and the climate sciences) to better understand their abundance, composition, aerosol lifetime, and the distribution and mixing state of individual aerosols in an indoor or outdoor environment.

8IM.4

Novel Laser Ionization Techniques for Single-particle Mass Spectrometry Reveal the Distribution of Key Compounds for Health Effects on Individual Particles. Johannes Passig, Julian Schade, Robert Irsig, Thomas Kröger-Badge, Sven Ehlert, Andreas Walte, RALF ZIMMERMANN, *Rostock University and Photonion GmbH*

Besides their climate effects, aerosols represent the largest environmental risk to human health (Lelieveld et al., 2015). The most health-relevant particle compounds are soot, metals and polycyclic aromatic hydrocarbons (PAHs). Single-particle mass spectrometry (SPMS) can detect them in real time (Pratt & Prather, 2012), however, limited sensitivity, matrix effects and molecular fragmentation limit chemical speciation in conventional SPMS. We address these challenges by developing new laser ionization approaches based on resonance effects.

One approach is the application of tunable laser systems, addressing atomic transitions of metals during their laser-driven release from the particle (Passig et al., 2020). This resonant laser desorption/ionization (LDI) enhances detection efficiencies for biologically relevant metals such as iron, zinc or manganese. We could show that important Fe-carriers in the atmosphere are not detected by conventional SPMS but by SPMS with resonant LDI.

We also combine Resonance-Enhanced Multiphoton Ionization (REMPI) of aromatic molecules with LDI of refractory compounds (Schade et al., 2019). This technology produces detailed PAH mass spectra combined with the particles' inorganic composition, providing novel insight into the sources, distribution and ageing of atmospheric PAHs.

In our commercial instruments, we combine both resonance techniques for PAHs and Fe, a key micronutrient for marine life and a particular health-relevant aerosol compound.

Here we present results from experiments on PAHs in ambient air, the detection of individual ship plumes from the distance and PAH-based source apportionment (Passig et al. 2021, 2022).

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8IM.5

Chemical Characterization of Gas-phase and Condensed Organics on a Molecular Composition Level by a Next Generation PTR-MS Instrument. MARKUS MUELLER, Tobias Reinecke, Zsolt Dányi, Markus Leiminger, Klaus Winkler, Todd Rogers, Alfons Jordan, *IONICON Analytik GmbH., Innsbruck, Austria*

We present a novel instrument for detecting gas-phase and condensed organics on a molecular composition level based on proton-transfer-reaction mass spectrometry (PTR-MS). FUSION PTR-TOF 10k (IONICON, Austria) features several enhancements compared to state-of-the-art PTR-MS technology.

The novel ion source improves the decoupling from the reaction chamber providing lowest interferences with neutrals and parasitic reagent ions. Within a single second, this source switches from quantitative proton-transfer-reaction with H_3O^+ primary reagent ions to almost fragmentation-free adduct ionization with NH_4^+. Ion-molecule reactions with organics occur in a fully-controlled environment of a novel ion-focusing RF reaction chamber (FUSION) operated at reduced pressures of 2-4 mbar. This guarantees the needed clean ion chemistry with ion-molecule reactions at predictable reaction energies (E/N) and reaction rates that are crucial for quantitative operation of a PTR-MS. With these enhancements, FUSION PTR-TOF 10k achieves lowest limits of detection (< 1 pptV in 1 s) and market-leading sensitivities up to 100.000 cps/ppbV at a TOF-MS mass resolution > 10.000 m/dm.

To measure condensed organics of low volatility, FUSION PTR-TOF is equipped with the new FUSION edition of the CHemical Analysis of aeRosol ON-line (CHARON) particle inlet. CHARON allows for a direct and quantitative detection of organic sub-µm particulate matter as well as particulate nitrate at ng/m^3 levels. Non-refractive sub-µm particles in a size range > 25 nm are efficiently evaporated at controllable desorption temperatures up to 250°C.

Herein we present a thorough characterization of this CHARON FUSION PTR-TOF 10k instrument and show first application results. We highlight the ability of FUSION to sequentially analyze gas and particle phases of a limonene oxidation experiment and demonstrate the advantages of the high sensitivity combined with a pristine ion chemistry in detecting the full range of fresh SOA.

8IM.6

Evaluating Quantification Capabilities of a New Higher-Resolution Aerosol Chemical Speciation Monitor for Long-Term Measurements of Non-Refractory Aerosol. BENJAMIN A. NAULT, Manjula Canagaratna, Philip Croteau, Edward Fortner, Andrew Lambe, Harald Stark, Donna Sueper, Leah Williams, Douglas Worsnop, John Jayne, *Aerodyne Research, Inc.*

Long-term measurements of the composition and mass concentration of particulate matter (PM) are essential for source apportionment, epidemiological studies, and air quality trends. The Aerosol Chemical Speciation Monitor (ACSM) has been widely used for in-situ, high time resolution measurements. However, current ACSMs have near unit mass resolution (UMR). UMR impacts detection limits and separation and identification of ions, limiting source apportionment. Further, uncertainty in organic aerosol (OA) relative ionization efficiency (RIE) in both ACSM and aerosol mass spectrometer (AMS) measurements can impact quantification. Here, we present a new instrument, the Time-of-Flight ACSM eXtended (TOF-ACSM-X) with updated analysis software (Tofware), to allow for high-resolution peak fitting. The TOF-ACSM-X has a mass resolution of ~2000 m/Δm, which is approximately an order of magnitude increase compared to the other current versions of ACSMs. This enhanced resolution improves ammonium detection limits by approximately 2-orders of magnitude, from ~0.10 μg m^{-3} to ~0.004 μg m^{-3} (TOF-ACSM versus TOF-ACSM-X, respectively), for 15-minute integration times. Intercomparisons of the TOF-ACSM-X with other measurements show improved performance in source apportionment and elemental analysis. The combined effects of thermal decomposition, ionization, and ion transmission efficiency on OA RIE values measured for the TOF-ACSM-X are discussed and compared with those measured for other ACSM and AMS instruments. The use of different OA RIEs for different sources and instruments will be discussed.

8IM.7

High Chemical Resolution Analysis of Atmospheric Organic Aerosol Using a Novel Thermal Desorption Gas Chromatograph infiTOF Mass Spectrometer (TD-GC-infiTOF). MICHAEL WALKER, Siqin He, Minoru Kano, Brent Williams, *Washington University in St. Louis*

Advances in mass spectrometry (MS) measurement techniques have been central to an increased understanding in the chemical composition of organic aerosol (OA) in the atmosphere. Coupling thermal desorption – gas chromatography (TD-GC) methods with MS allows for the separation of thousands of compounds in OA, but many of the detected compounds are not within existing databases, making identification challenging. High resolution mass spectrometers provide additional insight to the molecular formulas of any detected ions, but the resolution of field-deployable time-of-flight (TOF) mass spectrometers is often insufficient to fully characterize complex samples.

In order to overcome these challenges, an infiTOF mass spectrometer has been coupled to a TD-GC system to characterize complex environmental samples. The infiTOF can achieve very high resolution (~40,000) in a small footprint by sending ions through a tunable number of loops within the TOF region of the instrument. This approach allows for an operator to achieve high sensitivity measurements at lower MS resolution, or conversely lower sensitivity measurements at higher resolution to aid in the identification of unknown compounds. A range of chemical standards are used for the initial characterization of the TD-GC-infiTOF instrument to optimize the operating conditions that maximize the performance of the mass spectrometer in characterizing the eluting compounds. Furthermore, complex samples (e.g., biomass burning aerosol) are analyzed under the low- and high-resolution operating modes to demonstrate the strengths of the variable resolution offered by the TD-GC-infiTOF.

8RA.1

Small Particle Growth Observations at the U.S. DOE Southern Great Plains Field Site using Ambient Air Captive Aerosol Chambers.

ZIHAN ZHU, Xuanlin Du, Don Collins, *University of California, Riverside*

New particle formation (NPF) and growth influences the solar radiation budget and the microphysics and properties of clouds. Conventional approaches for studying NPF typically consider one or a small number of precursor gases or rely on observations of the dynamics of ambient particles. Traditional environmental chambers offer details of the species and processes that contribute to NPF, but are often limited to a narrow range of conditions and do not generally capture the complexity and variability of the atmosphere. The two portable 2-cubic meter Captive Aerosol Growth and Evolution (CAGE) chambers are designed to expose a controlled population of particles to an environment in which the air composition, temperature, and solar intensity mirror those just outside. Here we present results from the use of the CAGE chamber system at the DOE Atmospheric Radiation Measurement (ARM) Program's Southern Great Plains (SGP) site in the fall of 2021. Both chambers were operated continuously, with monodisperse seed particles injected every several hours and then intermittently measured by a scanning mobility particle sizer (SMPS). The aerosol was sometimes exposed to high humidity or high temperature upstream of the SMPS to characterize the hygroscopicity and volatility of the condensed species. The time-dependence of the growth rate for the 3-month study is quantified. The sensitivity of particle growth to the injected seed particle composition and liquid water content and to additions of precursor gases was studied by using one chamber as a baseline or reference chamber and the other as a perturbation chamber.

8RA.2

Marine Submicron Aerosols from the Gulf of Mexico: Polluted and Acidic with Rapid Production of Sulfate and Organosulfates.

SHAN ZHOU, Fangzhou Guo, Subin Yoon, Sergio Alvarez, Sujan Shrestha, James Flynn, Sascha Usenko, Rebecca J. Sheesley, Robert Griffin, *Rice University*

The Texas Gulf Coast experiences persistent air quality problems including elevated particulate matter (PM) concentrations. However, few studies have investigated the impact of air masses transported from the Gulf of Mexico. We made real-time measurements at a beachfront site in Corpus Christi, Texas, from April 2 – 22, 2021, using a high-resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS) to characterize the “background” aerosol chemical composition advecting into Texas and the factors controlling this composition. The average (±1σ) concentration of submicron aerosol (PM_1) during the sampling period was 15.6 (± 9.8) µg m^{-3}, with the maximum reaching nearly 100 µg m^{-3}. Sulfate was the most abundant component, on average accounting for 46% of total PM_1 mass, followed by organics (39%). Air masses arriving at the sampling site were frequently (58% of the sampling period) directly from the Gulf with negligible contact with land over the previous two days. The marine “background” aerosols from the Gulf shared similar characteristics with marine aerosols previously observed at other locations in the world, in that they had high sulfate content and appeared to be very acidic and aged. However, Gulf marine “background” aerosols were polluted; the average non-refractory PM_1 mass concentration (14.9 ± 10.0 µg m-3) was higher by a factor ranging from 3 to 70 compared to marine aerosols at other locations. Our analysis showed that anthropogenic shipping emissions over the Gulf of Mexico explain 78.3% of the total measured “background” sulfate in the Gulf air. Rapid growth of sulfate and acidic-oxygenated organic aerosol (acidic-OOA), an OA factor identified by positive matrix factorization analysis of the HR-ToF-AMS data, were observed during a two-day haze episode. Further analysis suggests that aqueous oxidation of ship emissions by organic peroxides in the particles might have been an important formation pathway for the sulfate-dominant haze episode.

8RA.3

Mass Spectral Characterization of Size Resolved Atmospheric Aerosol Particles Collected from Skidaway Island, GA. TRET BURDETTE, Rachel Bramblett, Kathryn Zimmermann, Amanda Frossard, *University of Georgia*

Atmospheric aerosol particles in a coastal environment are influenced by multiple sources and may include fresh and aged sea spray aerosols, as well as biogenic and anthropogenic particles. During a two-week period in May and June of 2018, atmospheric aerosol particles were collected at the Skidaway Institute of Oceanography, located on the Georgia coast. Sized-resolved particles in 10 size ranges were collected over 24-hour sampling periods, and accompanying number size distributions were measured continuously. HYSPLIT back trajectories suggest that air masses from two different source regions were influencing the particle number concentrations and compositions. During the first half of the study, air masses originated over the ocean, and there were higher wind speeds and lower particle concentrations (~800 cm^{-3}). The second half of the study had higher particle number concentrations (~3000 cm^{-3}), larger particles, lower wind speeds, and air masses coming from the west, over Savannah, GA. High resolution electrospray ionization quadrupole time of flight mass spectrometry (ESI-Q-TOF-MS), in both positive and negative ionization modes, was used to characterize the organic fraction of the aerosol particles extracted with graphitized carbon and C-18 solid phase extractions. Specific peaks were present in the mass spectra across all 10 size ranges, while others varied in intensity as a function of particle size. Concentrations of major ions (Na^+, K^+, Ca^{2+}, Mg^{2+}, NH_4^+, Cl^-, and SO_4^{2-}) in the particles were compared to organic signatures to infer the influences of different sources. The results suggest that aged sea spray aerosols influenced the particles from the first half of the study, indicated with high O/C values and spectral signatures that compared well with those of organic molecules extracted from estuarine water collected at the sampling site. The spectral signatures of the organics differed in the second half of the study and had more anthropogenic and terrestrial influences.

8RA.4

Chemical Characterization of Individual Sea Spray Aerosol Particles from the Arctic and North Atlantic Regions. JESSICA MIRRIELEES, Rachel Kirpes, Amanda Grannas, Vanessa Boschi, Nurun Nahar Lata, Swarup China, Patricia Matrai, Andrew Ault, Kerri Pratt, *University of Michigan*

Sea spray aerosol particles (SSA) are produced by wave-breaking in surface seawater. Nascent SSA consist of a core, composed primarily of sodium chloride, which is often coated in organic materials. The chemical composition of SSA is influenced by the elemental ratios of seawater ions, the production of organic compounds by the marine biological community, and atmospheric aging. SSA composition influences local atmospheric chemistry, and it has been demonstrated that measurements of individual salt-containing aerosol particles are necessary for closing the gap between modelled and observed production of ClNO2, a source of reactive chloride in the atmosphere.

Variations in SSA chemical composition may result from the status of the marine microbial community. The production of organic material in the local seawater increases during a phytoplankton bloom, though the effect on SSA composition is unclear. The production of SSA in the Arctic is predicted to increase as global temperatures continue to rise. Chemical characterization of SSA in the Arctic is necessary for constraining the consequences of this growing source of aerosol particles.

To this end, ambient SSA particles were sampled near Utqiaġvik, AK, from onboard an icebreaker in the High Arctic, and from a North Atlantic coastal site (East Boothbay, ME). SSA particles were also generated using a marine reference tank with water sampled from a coastal North Atlantic location (East Boothbay, ME). Another series of marine aerosol generation experiments were carried out onboard an icebreaker using water sampled from the High Arctic.

Aerosol particles were collected onto substrates using a Micro-Orifice Uniform Deposition Impactor (MOUDI) or a Davis Rotating-Drum Unit for Monitoring (DRUM). Thousands of individual aerosol particles from each location were subsequently analyzed using electron microscopy with energy-dispersive x-ray analysis, Raman microspectroscopy, and optical-photothermal infrared microspectroscopy in order to gain insight into chemical properties of SSA particles from different environments.

8RA.5

Multi-year Gas and Particle Sensor Observations in Rural and Urban Malawi. ASHLEY BITTNER, Eben Cross, David Hagan, Jared Bowden, Jason West, Tim Glotfelty, Andrew Grieshop, *North Carolina State University*

In situ air quality measurements are nearly nonexistent in much of southern Africa, including in Malawi, a small land-locked country. From 2017 to 2021, we deployed eight moderate-cost integrated sensor packages that measure CO, CO_2, O_3, NO, NO_2, particulate matter from 0.38 to 17 micrometers in diameter, and meteorological parameters (i.e., wind speed and direction, temperature, relative humidity, pressure, noise, and solar intensity) to four sites in Malawi. We deployed the sensor packages to three regions to characterize spatiotemporal trends and identify contributions from emission sources in urban and rural settings. Diurnal trends from rural village sites show peaks in the ambient CO and $PM_{2.5}$ concentration twice a day at mealtimes, likely due to emissions from nearby biomass cookstove activity. Peak concentrations were highest in the rural, residential villages although urban areas had higher background pollution levels. Pollutant concentrations were lower in the wet season for all sites, likely due to atmospheric removal processes (e.g., precipitation) combined with reduced outdoor cooking activity. Annual and seasonally averaged concentrations show that background pollution concentrations across Malawi increase during the hot, dry season, when prescribed burning for agricultural land management is common in the region. Annual cumulative burned area data from southeastern Africa show that most of the seasonal burning activity occurs outside Malawi's borders, indicating the increase in pollution is likely due to transport of regional emissions from neighboring countries. Analysis will explore how seasonal pollution and weather patterns in Malawi may be influenced by regional wind patterns (via HYSPLIT simulation) and nearby geographical features. Surface observations will be compared to remote sensing and reanalysis data products and with results from chemical transport model simulations. Finally, we will characterize multi-year changes in pollutant concentrations and meteorological conditions (e.g., $PM_{2.5}$, temperature), including an exploration of potential impacts from the COVID-19 pandemic.

8RA.6

Aerosol Properties and Processes in the Eastern North Atlantic. JIAN WANG, Guangjie Zheng, Yang Wang, Meinrat O. Andreae, Michael Jensen, Daniel Knopf, Chongai Kuang, Alexander Laskin, Alyssa Matthews, Fan Mei, Ryan Moffet, Arthur J. Sedlacek, John Shilling, Amy P. Sullivan, Jason Tomlinson, Janek Uin, Daniel Veghte, Rodney J. Weber, Rob Wood, Maria Zawadowicz, *Washington University in St. Louis*

With their extensive coverage, marine low clouds strongly impact global climate. Presently, the response of marine low clouds to changes of atmospheric aerosols remains a major source of uncertainty in climate simulations. The Eastern North Atlantic (ENA) is a region of persistent but diverse subtropical marine boundary layer clouds, whose albedo and precipitation are highly susceptible to perturbations in aerosol properties. In addition, ENA is periodically impacted by continental aerosols from North America, making it an excellent location to study the cloud condensation nuclei (CCN) budget in a remote marine region periodically perturbed by anthropogenic emissions.

The aerosol properties and the processes that drive the CCN population in the ENA are examined by combining the airborne measurements during the Aerosol and Cloud Experiments in Eastern North Atlantic (ACE-ENA) campaign and long-term observations at a ground site on Graciosa Island in the Azores. We show that new particle formation occurs regularly in the upper part of remote marine boundary layer (MBL) following the passage of cold fronts, and this new particle formation likely represents a substantial source of CCN in the MBL. The entrainment of free troposphere (FT) air is a major source of Aitken mode particles in the MBL, which can subsequently grow and reach CCN size range. We found that secondary organics represent important or even the dominant condensing species during ~80% of particle growth events observed during the ACE-ENA. The condensational growth of nucleation/Aitken mode particles represents a major source of CCN in the MBL, and it may be underestimated in global models. Elevated accumulation mode particle concentration was observed in the lower FT during summer and is attributed to more frequent long-range transport of continental emissions from North America. The variations of the aerosol properties and processes with season and synoptic conditions are also examined.

8RA.7

Evaluation of High-resolution GEOS-Chem Nested Grid Simulations over Africa Using a Novel Surface PM2.5 Dataset.

DANIEL WESTERVELT, Garima Raheja, Kokou Sabi, Emmanuel Appoh, Allison Felix Hughes, Benjamin Yang, Paulson Kasereka,
Columbia University

Air pollution is a growing problem in Africa, with around 1 million premature deaths attributed to poor air quality in 2019 on the African continent. Although measurements of PM2.5 and gaseous air pollutants on the continent are very sparse, new efforts by both African and international organizations have increased public data availability in recent years. New networks of PM2.5 rely on both reference monitoring and consumer-grade low cost sensors, the latter of which, if well calibrated, have been proposed as a potential means of closing this data gap in Africa. These emerging datasets provide a unique opportunity to evaluate regional and global chemical transport models over Africa so that projections and predictions from such modeling efforts can be more reliable. We simulate atmospheric chemistry, emissions, transport, deposition, and meteorology using the GEOS-Chem chemical transport model. We employ a 25 by 25-kilometer horizontal spatial resolution regional nested simulation over equatorial Africa and simulate meteorological years 2020 and 2021, allowing us to take advantage of novel surface observations established in only the last two years. Emissions in Africa are from the DICE-Africa inventory. We evaluate daily, monthly, and hourly surface PM2.5 in several cities, including: Accra, Ghana; Lomé, Togo; Kinshasa, DRC; Brazzaville, ROC; Kampala, Uganda; Nairobi, Kenya; Addis Ababa, Ethiopia; and more. Initial results show that this high-resolution model reproduces surface PM2.5 reasonably well. In Accra, March – October 2021 modeled surface 24-hour mean PM2.5 was moderately well correlated with surface observations ($r^2 = 0.57$). Overall, the model underpredicted PM2.5 in March-October 2021, with an average of 23.6 $\mu g\ m^{-3}$ observed PM2.5 versus 18.8 predicted by GEOS-Chem. These findings will help inform and ultimately improve air quality modeling efforts over Africa.

9AC.1

The Hygroscopicity of Functionalized Insoluble Aerosol Surfaces. CHUN-NING MAO, Kanishk Gohil, Akua Asa-Awuku, *University of Maryland*

Insoluble particles can provide a surface for water molecules and can act as cloud condensation nuclei(CCN) under supersaturated conditions. The water-uptake process (hygroscopicity) depends on the bulk chemistry of the nuclei and the chemical and physical surface properties. However, the impact of molecular surface chemistry for CCN activity has remained elusive; the porous structure and the non-sphericity of particles have made aerosol measurement and CCN prediction challenging. To understand the role of the surface chemistry in the water uptake, we study the CCN activity of non-porous, spherical polystyrene latex (PSL) particles with ($PSL-NH_2$ and PSL-COOH) and without (plain PSL) surface modification. Three thermodynamic models, traditional Köhler theory, the Flory-Huggins Köhler theory and the Frenkel-Halsey-Hill adsorption theory (FHH-AT) predict the activation behavior. Among all, the Frenkel-Halsey-Hill adsorption theory, with two parametrizations, A_{FHH} and B_{FHH}, is the only model capable of agreeing with measurement and predicting the slight differences between the different molecular level functions on PSL surfaces. $PSL-NH_2$ has the highest CCN activity, while the plain type PSL shows the lowest. The B_{FHH} parameter represents the interaction between the bulk nuclei and the water molecules and when B_{FHH} is constrained to unity, the A_{FHH} for $PSL-NH_2$, PSL-COOH and plain PSL is 0.23, 0.21, and 0.18 respectively. The results of the constrained fit imply that the CCN activity of the functionalized surface correlates to the polarity of functionalized groups. Lastly, we develop a single parameter hygroscopicity representation for insoluble aerosol derived from principles of the FHH-AT model. We demonstrate that the hygroscopicity based on FHH-AT model can predict the decreasing trend with the dry particle size of insoluble particles.

9AC.2

Effects of NOx on the Formation of Reactive Oxygen Species and Environmentally Persistent Free Radicals from Biogenic and Anthropogenic Secondary Organic Aerosols. KASEY EDWARDS, Alexandra Klodt, Tommaso Galeazzo, Meredith Schervish, Jinlai Wei, Ting Fang, Bernard Aumont, Sergey Nizkorodov, Manabu Shiraiwa, *University of California, Irvine*

Reactive oxygen species (ROS) such as hydrogen peroxide (H_2O_2), superoxide (O_2^-), hydroxyl radical ($^{\cdot}OH$), and hydroperoxy radical ($HO_2^{\cdot}$) play an important role in chemical transformation of aerosols in the atmosphere and adverse aerosol health effects. Aqueous reactions of secondary organic aerosol (SOA) compounds, such as organic hydroperoxides and alcohols, can lead to the formation of ROS. Environmentally persistent free radicals (EPFRs) with longer lifetimes, from minutes to months, are contained in SOA derived from aromatic precursors. This study investigated whether the presence of NOx during SOA formation, which is known to affect SOA chemical composition, has an impact on the EPFR content of SOA and formation of ROS from SOA. SOA produced by OH oxidation of alpha-pinene and naphthalene under low-NOx and high-NOx conditions was analyzed with electron paramagnetic resonance (EPR) spectroscopy to quantify the concentrations of ROS and EPFRs. The analysis showed that alpha-pinene and naphthalene SOA generated without NOx forms OH radicals and superoxide in the aqueous phase, which can be reduced by 50-80% for SOA generated in the presence of NOx. High resolution mass spectrometry analysis showed the formation of organic nitrates in a high NOx environment. The GECKO-A model, an automated and explicit gas-phase chemistry model, was used to compute the amounts of different functional groups present in alpha-pinene SOA. The Radical 2D-VBS model, which includes autoxidation and dimerization, was also used to compute the formation of organic hydroperoxides. Both model outputs showed that the formation of hydroperoxides would be dramatically reduced under a high NOx environment due to the reactions of peroxy radicals with NOx instead of their reactions with HO_2.

9AC.3

The Chemical Fate of Sulfur in Thiophene against Nitrate Radical Oxidation. MICHAEL LUM, Kunpeng Chen, Alexander B. MacDonald, Nilofar Raeofy, Raphael Mayorga, Haofei Zhang, Roya Bahreini, Ying-Hsuan Lin, *University of California, Riverside*

Thiophene is a sulfur-containing volatile heterocycle emitted during the combustion of biomass. While current literature has reported the formation of secondary organic aerosol from nighttime oxidation of organosulfur compounds, the transformation of S-containing volatile organic compounds (VOCs) leading to the production of organic and inorganic sulfate, as well as non-sulfate sulfur in atmospheric aerosols is less studied. This study intends to use thiophene as a model compound to investigate how such compounds contribute to formation of organosulfate and inorganic sulfate in aerosols. Thiophene was oxidized by nitrate radicals in a 10 m^3 environmental chamber, under NOx/ozone ratios of 0.1 and 0.3 to simulate various levels of the NO_3 oxidant. The fate of sulfur under these conditions will be explored using the following techniques: (1) the resulting inorganic sulfate to organosulfate ratios will be determined through ion chromatography (IC) and aerosol mass spectrometry; (2) oxidation state of sulfur in S-containing molecules will be obtained through X-ray photoelectron spectroscopy; and (3) the molecular composition and structures of the resulting organosulfur and organosulfate compounds will be determined through high-resolution mass spectrometry. Organosulfur and inorganic sulfate aerosols both have significant climatic implications in the atmosphere. Oxidation of thiophene and other sulfur-containing VOCs could prove to be an important, currently unaccounted for, source of these two atmospheric pollutants of interest.

9AC.4

Unexpected Reduction of Phenolic SOA Formation in the Presence of Electrolytic Inorganic Seed. JIWON CHOI, Myoseon Jang, *University of Florida*

Phenolic hydrocarbons are abundant in biomass burning gases. They can be rapidly oxidized with atmospheric oxidants and form Secondary Organic Aerosol (SOA). In this study, The SOA formation potential from phenol and *o*-cresol, which are the typical phenolic hydrocarbons in biomass burning smoke, are investigated through chamber studies and the model simulation. Phenol or *o*-cresol is photochemically oxidized in the Atmospheric Photochemical Outdoor Reactor (UF-APHOR) under the various conditions, such as NO_x levels, humidity, temperature, and seed conditions. In our exploratory chamber study, the unexpected low SOA yield is observed for the oxidation of phenolic hydrocarbons in the presence of salted aqueous aerosol and it is even lower than no-seeded SOA. We propose that a persistent phenoxy radical heterogeneously forms in the wet inorganic aerosol and it interferes the atmospheric oxidation capability. For example, heterogeneously formed phenoxy radicals evaporate into the gas phase via gas-particle partitioning, and they fast deplete ozone. Ultimately, SOA formation can be suppressed due to the lack of the OH radical formation. The UNIPAR model that simulates SOA formation via multiphase reactions of hydrocarbons, is employed to predict the SOA formation from the photooxidation of phenol and *o*-cresol under varying atmospheric conditions. This model uses a volatility-reactivity base 2-D lumping array, which uses oxygenated products predicted from near explicit gas mechanisms. The UNIPAR model is capable of predicting the chamber-generated phenolic SOA mass in the absence of seed aerosol, but unsuccessful for seeded SOA due to the intervention of heterogeneously formed phenoxy radicals. The finding of this study can help to explain the low SOA yields observed during wildfires and biomass burning under the specific conditions associated with the wet inorganic aerosol.

9AC.5

Acid-Base Interaction of Nicotine With Benzoic Acid in Vaping Aerosols, Studied with X-Ray Spectroscopy. HASHINI WEERARATNA, Xiaochen Tang, Oleg Kostko, Vi Rapp, Lara Gundel, Hugo Destaillats, Musahid Ahmed, *Lawrence Berkeley National Laboratory*

Carboxylic acids are used as additives in electronic cigarette e-liquids to form a “salt” with nicotine, making the puffs less harsh upon inhalation. Such formulations contain 3 to 6 times higher nicotine levels than conventional e-liquids, facilitating initiation and addiction. Benzoic acid (BA) is a popular additive, normally present in a 1:1 ratio with respect to nicotine. The association of BA and nicotine in freshly emitted aerosols was studied using X-ray photoelectron spectroscopy (XPS) and near edge X-ray absorption fine structure spectroscopy (NEXAFS) on an instrument developed at the Advanced Light Source. Stable aerosols streams were generated from mixtures of water, propylene glycol (PG) and glycerol in different proportions, with added nicotine and BA. Particles of 50 – 1,000 nm diameter were admitted through a 200-µm nozzle aerodynamic lens system. The particle number, mass and surface concentration were determined with a Fast Mobility Particle Sizer spectrometer, an Optical Particle Sizer and an Aerodynamic Particle Sizer, in the range of 8 – 2,500 nm. In XPS, the C 1s and N 1s photoelectron spectra were recorded at a photon energy of 315 eV and 430 eV, respectively. Density Functional calculations were performed for band assignments to the photoelectron spectra. The analysis was supported by NEXAFS of the C and N edge. The relative fraction of free base and protonated nicotine were calculated from the N spectra, enabling for an assessment of the association ratio and nicotine free base fraction, by changing experimental conditions that are relevant for vaping, such as PG/glycerin ratio and the water content. Raman spectroscopy of the solutions from which the vaping aerosols were generated was used to corroborate their composition and compare and contrast to the aerosol chemistry deciphered via X-Ray spectroscopy. These results can contribute to new insights on users’ chemical uptake and passive exposures.

9AC.6

Laboratory Investigation of ClNO2 Production from Environmental Samples Collected Near the Great Salt Lake. JAMES CHRISTIE, Sean O'Connel-Lopez, Kevin Perry, Kerri Pratt, Cassandra Gaston, *University of Miami*

In recent years, Salt Lake City has experienced increased wintertime ozone (O3), which is a criteria air pollutant and greenhouse gas. A potential source of wintertime O3 is thought to be the nighttime reaction between chloride containing aerosols and dinitrogen pentoxide (N2O5) which leads to the production of nitryl chloride (ClNO2). In the daytime, ClNO2 will then photolyze to produce chlorine radicals (Cl•), which is a precursor to O3. However, the sources of these chloride containing aerosols in the Great Salt Lake Basin, and their subsequent reaction kinetics remain unclear. To better understand this, we analyzed environmental samples collected near the Great Salt Lake and Salt Lake City to investigate their ClNO2 forming potential. To simulate realistic wintertime conditions where chloride containing aerosols react with N2O5 we used an aerosol kinetic flow tube under varying relative humidities. To analyze the kinetic uptake of N2O5 and propensity to generate ClNO2 of our samples, we utilized chemical ionization mass spectrometry (CIMS) coupled to an aerodynamic particle sizer (APS) and scanning mobility particle sizer to determine our surface area concentrations and calculate the reactive uptake of N2O5. Coupling the CIMS with aerosol time of flight mass spectrometry (ATOFMS), we were able to simultaneously determine the chemical composition of our samples and explore how aerosol size-resolved composition impact ClNO2 production. This work highlights how the varied chemical composition of our samples affects the formation of ClNO2 while simultaneously calling attention to potential sources of wintertime O3 in Salt Lake City.

9AC.7

Simultaneously Characterizing the Volatility Distribution and Phase State of Laboratory-Generated and Ambient Aerosol Particles with a Vocus Chemical Ionization Mass Spectrometer.

SINING NIU, Jordan Krechmer, Harald Stark, Yue Zhang, *Texas A&M University*

Aerosols are ubiquitous in the atmosphere and play critical roles in both climate and human health. Recent studies have shown that the physicochemical properties of organic aerosols, including the volatility and phase state, have significant implications on their growth, gas-particle partitioning, chemical reactivity, and climate impacts. Nevertheless, obtaining the online volatility and especially phase state information of atmospheric particles has been challenging, and limited our abilities to accurately predict their growth, evolution, and climate implications.

This study establishes a novel real-time online method for the first time to obtain both the volatility distribution and phase state with the Vocus 2R Chemical Ionization Mass Spectrometer and Vocus Inlet for Aerosols (Vocus 2R/VIA). A calibration function linking thermal desorption temperature to known saturation mass concentration (C^*) is first established using six pure organic aerosols, covering a range from 0.001 – 1000 μg m^{-3}. The volatility distribution of secondary organic aerosols (SOA) is determined by using multi-linear regression fitting on the desorption curve with calibration data.

The viscosity value, a parameter to characterize aerosol phase state, is subsequently quantified by combining the volatility distribution, a volatility-glass transition parameterization, and the Vogel-Tammann-Fulcher (VTF) equation at any given temperature and relative humidity (RH). This method is further validated using lab-generated α-pinene and β-caryophyllene SOA from ozonolysis reactions, with the derived viscosity values agreeing with previous literature findings.

The above method is applied during the Tracking Aerosol Convection Interactions Experiment (TRACER) field campaign to determine the real-time volatility and viscosity of ambient aerosols. Combined with the real-time meteorological conditions (such as RH and temperature) and inorganic chemical composition from a high resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS), the phase state of complex ambient particles could be determined at a much higher time resolution, further constraining the formation, reaction, and climate effects of aerosol particles.

9AC.8

The Relationship of Air Pollution Sources and the Oxidative Potential of Particulate Matter (PM) in Different Cities Around the World.

VAHID JALALI FARAHANI, Constantinos Sioutas, Ramin Tohidi, Abdulmalik Altuwayjiri, *University of Southern California*

In this study, six sets of PM samples were collected in five urban location sites around the world which were selected for their PM to be dominated by unique emission sources: 1) PM2.5 emitted mainly by traffic emissions in central Los Angeles, United States (US); 2) PM2.5 produced by biomass burning activities in Milan, Italy; 3) PM2.5 formed by secondary photochemical reactions thus dominated by secondary aerosols in Athens, Greece; 4) PM10 emitted by refinery and dust resuspension in Riyadh, Saudi Arabia (SA); 5) PM10 generated by dust storms in Riyadh, SA, and 6) PM2.5 produced mainly by industrial and traffic emissions in Beirut, Lebanon. Chemical composition and associated oxidative potential of these PM samples were quantitatively analyzed to characterize the sources and their resulting health impacts. The dithiothreitol (DTT) assay was employed to quantify the corresponding oxidative potential of each PM sample. The results revealed that the Milan's ambient PM were rich in water soluble organic carbon (WSOC) and PAHs, tracers of biomass burning during the cold period, while PM in Athens exhibited high levels of inorganic ions, further corroborating the impact of photochemical reactions in this city. The ambient PM in LA was impacted by the traffic-emitted primary organic and elemental carbon. Additionally, the contribution of metals and elements per mass of PM in Riyadh and Beirut samples were more pronounced relative to other location sites. The highest intrinsic PM redox activity was observed for PM with the highest WSOC fraction, including Milan (biomass burning) and Athens (secondary organic aerosols, SOA). PM in areas characterized by high metal emissions such as Riyadh and Beirut, constituted the lowest oxidative potential as shown by the DTT assay.

9AC.9

Roles of Sufluric Acid, Ammonia, and Amines on New Particle Formation in Kent, Ohio. Buddhi Pushpawela, SHANHU LEE, Lee Tiszenkel, *The University of Alabama in Huntsville*

New particle formation (NPF) is the major source of secondary aerosol particles in the atmosphere. NPF events have been observed in different environments around the world, including in urban, industrial, agricultural, and coastal sites, as well as boreal forests and polar regions. Sulfuric acid, ammonia, amines, and highly oxygenated organic molecules (HOMs) are considered the main precursors for NPF. Recent studies have shown that sulfuric acid-amine nucleation may be the key NPF process in polluted urban sites (such as Shanghai, Beijing, and Barcelona). While there have been a large number of measurements of aerosol size distributions, still, simultaneous measurements of aerosol sizes and NPF precursors are extremely limited. We made simultaneous measurements of aerosol sizes, sulfuric acid, ammonia, and C1-C6 amines in the fall of 2013 in Kent, Ohio. This site has abundant sulfuric acid due to emissions from surrounding power plants, and frequent NPF events were observed during long-term observations. In this presentation, we will present data analysis of our unique in-situ measurements, based on the current NPF algorithms provided by the CLOUD chamber experiments. We will discuss the importance of sulfuric acid-amine nucleation, as well as the synergetic effects of ammonia and amines, on NPF, and explore the potential contribution of HOMs to NPF.

9AC.10

Molecular Chemical Speciation of HOMs in Urban Aerosols with FIGAERO CI-APi-TOF and LC-ESI-Orbitrap High-Resolution Mass Spectrometers. LEE TISZENKEL, Asadullah Shoaib, Sameera White, Rachel Hurley, Yue Zhang, Shanhu Lee, *University of Alabama Huntsville*

The Southeastern United States has a unique atmospheric condition for atmospheric organic aerosol formation due to strong oxidation reactions of abundant biogenic and anthropogenic VOCs under various pollutant conditions such as SO2 and NOx. At present, there are very limited methods that can determine the molecular identification of organic aerosols, especially highly oxygenated organic molecules (HOMs). We will present the molecular level chemical identification of aerosol-phase HOMs with two high-resolution mass spectrometer techniques using off-line filter samples collected in Huntsville, Alabama (an urban site with strong emissions of biogenic VOCs). The LC (Liquid chromatography) – ESI (electrospray ionization) Orbitrap high-resolution mass spectrometer provides detailed chemical identification of organic species containing C, H, O, N, and S, with MS/MS analysis. The CI-APi-TOF (Chemical Ionization Atmospheric Pressure interface Time-of-Flight) mass spectrometer with the FIGAERO (Filter Inlet for Gases and AEROsols) can measure volatility of various HOMs. Thus, these two high-resolution mass spectrometer measurements can complement each other and provide unique molecular insights on HOMs in urban organic aerosols for a better understanding of their formation processes.

9AC.11

Synthesis of Oxidation Products from Biogenic Volatile Organic Compounds in the Atmosphere: A Review. SAHIR GAGAN, Kumar Sarang, Ruizhe Liu, Yue Zhang, *Texas A&M University*

Volatile organic compounds (VOCs) emitted by plants, such as isoprene, terpenes (e.g., α-pinene and β-caryophyllene), and green leaf volatiles are large contributors to the total organic aerosol budget. VOCs undergo reactions with oxidants such as hydroxyl radical (·OH), nitrates (NO_3), ozone (O_3) followed by physical and multiphase processes to form secondary organic aerosols (SOA). Owing to the complex nature of reaction pathways, multiple intermediate species may form from one precursor at different stages of the reaction. Presently, to characterize these SOA precursors and components, a combination of various high resolution (HR) offline and online analytical techniques like gas chromatography-mass spectrometer (GC-MS), liquid chromatography-mass spectrometer (LC-MS), time of flight-aerosol mass spectrometer (ToF-AMS) are employed. Accurate identification and quantification of these compounds require authentic standards from organic synthesis, making it crucial in understanding the formation and the associated impacts of SOA on air quality, climate, and health.

In this review we have encompassed the progress made in the synthesis of authentic reference marker compounds for SOA originating from biogenic VOCs (BVOCs). Our review is a collection of synthetic procedures developed and reported till date, organized based on the order of appearances during the oxidation reactions of BVOC. We also group the target compound under various atmospheric conditions including of ozonolysis as well as high NOx and low NOx oxidations. This review also includes existing gaps between the current synthetic methods and missing key authentic standards, to further improve understandings in the reaction pathways of SOA formation.

This review is the first based on what we know to systematically summarize current known synthetic pathways of SOA standards from BVOCs oxidations. We hope that the review can further connect synthetic chemistry with atmospheric chemistry and provide the community with tools to identify and quantify key species during complicated reactions that lead to SOA formation.

9AC.12

Understanding the Atmospheric Chemistry and Physicochemical Properties of Secondary Aerosol Formation from Gas- and Aqueous-phase Oxidation of Methylated Selenium Species. NINGJIN XU, Yumeng Cui, Michael Lum, Ying Zhou, Roya Bahreini, Ying-Hsuan Lin, Don Collins, *University of California, Riverside*

Aerosols have a wide variety of impacts on air quality, global climate, and human health, with the magnitude of those effects dependent on the composition of the aerosol. There has been only limited research on the sources of trace toxic components of aerosols in agricultural environments. Selenium (Se) is an essential trace element present in various forms in the environment and is cycled through biogeochemical processes. Among the most abundant species, the gaseous methylated selenium compounds, such as dimethyl selenide (DMSe) and dimethyl diselenide (DMDSe), are the major volatile organoselenium compounds and are emitted from both natural and anthropogenic sources. Atmospheric oxidation of those and other organoselenium species can result in formation of secondary aerosol, though the pathways and products of the chemistry remain largely unknown. Recent chamber studies have reported the aerosol formation yield, composition, and health-related characteristics of the products of gas-phase oxidation of DMSe. However, little is known about how the composition and Se oxidation state evolve with continued atmospheric processing through both gas- and aqueous-phase chemistry and how those changes affect physicochemical properties such as solubility, mobility, and toxicity.

In this work, systematic studies of gas- and aqueous-phase oxidation of several methylated selenium compounds have been carried out in a modified oxidation flow reactor under variable precursor concentration, seed type, oxidant type (OH and O3), and oxidation time scale. The results are used to develop an improved understanding of the atmospheric fate of these compounds and the potential impact of the oxidation products on health. We will present initial results of the secondary aerosol formation yield as a function of OH exposure for gas-phase oxidation and for gas+aqueous-phase oxidation in the presence of aqueous seed particles or cloud droplets. The composition of the Se-containing secondary aerosol is measured using a mini time-of-flight aerosol mass spectrometer (mAMS) and a chemical ionization time-of-flight mass spectrometer (CIMS).

9AC.13

Multi-Phase Product Distribution of Cl-Initiated VOC Oxidation. HANNAH KENAGY, Lesly Franco Deloya, Jesse Kroll, *Massachusetts Institute of Technology*

Chlorine-radical-initiated chemistry is important in marine, wintertime, and Arctic environments. However, key uncertainties still exist, particularly regarding the full product distribution of Cl-initiated oxidation of volatile organic compounds (VOCs) and the ultimate fate of chlorine in these processes under varied environmental conditions. Previous laboratory studies suggest that Cl-initiated oxidation of VOCs produces oxygenated VOCs and organochlorides, some of which partition to the particle phase as secondary organic aerosol (SOA). Here we perform a series of laboratory experiments to explore the full product distribution of Cl-initiated oxidation from a range of VOCs under a range of reaction conditions. Products in both the gas and particle phases are measured using chemical ionization mass spectrometry and aerosol mass spectrometry. Measurements of the multi-phase product distribution accessible through these techniques allow for an improved understanding of the chemical mechanisms and phase-partitioning involved in Cl-initiated VOC oxidation, thereby improving our ability to model VOC oxidation and SOA formation under conditions in which tropospheric halogen chemistry is important.

9AC.14

Biofuel-Specific Molecular Composition of Organic Aerosol in Biomass Burning Smoke. KYLA SIEMENS, Theo Paik, August Li, Felipe Rivera-Adorno, Jay Tomlin, Rajan K. Chakrabarty, Alexander Laskin, *Purdue University*

Organic aerosol (OA) emitted from wildfires and prescribed forest and agricultural burning have diverse composition that undergo complex reactions and transformations in the atmosphere, leading to profound impacts on air quality, climate, and atmospheric chemistry. Emission characteristics are strongly dependent on regional vegetation, with different fuels resulting in substantially different OA component profiles. Understanding the emission profiles of these biomass fuels is fundamental in predicting their impact on atmospheric consequences of wild and prescribed fires. In this work, we characterize OA emissions of peat, sage grass, grass, and ponderosa pine burned in controlled laboratory environments. We utilize ultra-high-performance liquid chromatography coupled to a photodiode array detector and electrospray ionization high-resolution mass spectrometer (UPLC-PDA-ESI-HRMS) to investigate molecular characteristics of smoldering-phase emissions to model the contributions of these fuels in real-world burns. We showcase a method to determine the volatility profiles of the OA samples representative of studied fuel-types and their relationship to the light-absorbing properties of brown carbon (BrC) with respect to four optically based BrC classes (very weak, weak, moderate and strongly absorbing). This method of classification is practical for analyzing and comparing light absorbing OA samples and is applicable for both laboratory-based and real-world studies.

9AP.1

Improved Discrete Random Walk Model for Turbulent Tracking of Particle Transport. SREEKESH KOOKKAL, Suresh Dhaniyala, *Clarkson University*

The transport of inertial particles in turbulent flow can be solved using a stochastic model, where the instantaneous particle velocity is calculated from the mean velocity and the instantaneous turbulent velocity fluctuation. In the DRW model, the fluctuating component of velocity is treated as the discrete piecewise, the constant function of time. Earlier studies with commercial computational fluid dynamics (CFD) software such as FLUENT, have shown that particle transport loss due to turbulence is often over-predicted with the built-in Discrete Random Walk (DRW) model. This over-prediction also impacts the accuracy of particle concentration predictions in the bulk flow, resulting in erroneous calculations of particle concentrations in scenarios such as in the flow downstream of nozzles and orifices. We developed a DRW model for use with FLUENT that improves the accuracy of particle transport in k-ϵ and SST k-ω turbulence models. We use channel flow simulations conducted for a bulk Reynolds number 2280 and a non-dimensional relaxation time varied from 0.01 to 25 to evaluate our model. We will present a comparison of particle transport statistics such as concentrations and mean and RMS particle velocity for different DRW models with the Direct Numerical Simulation (DNS) data.

9AP.2

An Exploration of the Effects of Rayleigh-Benard Turbulence on the Dry Deposition of Aerosols in the Pi Chamber. JACOB KUNTZLEMAN, Abu Sayeed Md Shawon, Ian Helman, Prasanth Prabhakaran, Raymond Shaw, Will Cantrell, *Michigan Technological University*

Aerosol particles with diameters ranging from nanometers to micrometers are important in the study of many biological systems, clouds, and climate. Dry deposition of aerosols is one of the main mechanisms by which aerosols are removed from Earth's atmosphere, and is therefore an important contribution to aerosol number and mass budgets. Recent work has highlighted uncertainties in the rate at which aerosols are deposited to a variety of natural surfaces under turbulent conditions. We measured the removal of aerosol particles ranging from 50 nm to 2 µm diameter in a dry, turbulent flow. The turbulence was maintained in the Pi Chamber via Rayleigh-Benard convection with a temperature gradient of 19 K across the 1 m height—i.e. a Rayleigh number of order 10^9. The results are qualitatively consistent with earlier studies in finding two deposition regimes: the characteristic settling time, τ, for the decay by deposition of large particles ($d_p > 600$ nm) is dominated by gravitational settling, as shown by the inverse square dependence of τ on particle diameter, d_p, while the characteristic deposition time of small particles ($d_p < 600$ nm) obeys $\tau = \alpha d_p^{0.23}$, where α is independent of particle diameter but depends on chamber properties and turbulence intensity. The deposition of small particles is partly understood to be a result of diffusive effects, but the dependence of the characteristic settling time on particle diameter is weaker than that predicted by diffusion alone. The relative contributions of turbulent dispersion, thermophoresis, and electrostatics forces are considered. We finally present some preliminary evidence that small particle deposition rates are a function of turbulence strength.

9AP.3

Observation of Atmospheric Particle Electrostatic Charging States in Urban and Rural Regions. YUTO ISHII, Tatsuhiro Mori, Ayumi Iwata, Atsushi Matsuki, Tomoaki Okuda, *Keio University*

Atmospheric particulate matters emitted from various sources on the earth have adverse on human health by deposition on the lungs. In particular, particles with a diameter of 2.5µm or less, called PM2.5 have more adverse effects because they can be breathed deeper into the lungs. However, how the various characteristic of the particles act on human health is a complicated process and not yet fully understood. Several laboratory experiments and numerical simulations have reported that the charging state of the particles influences their deposition on the human airway. Regarding outdoor research, it has been suggested that the presence of ions and charged particles may be linked to several adverse health effects such as respiratory and cardiological conditions. In order to clarify the relationship between the electrostatic charging state of atmospheric hundreds nanometer particles and human health effects, we developed the parallel-plate particle separate device (Keio Measurement system of Aerosol Charging State; K-MACS) for separating particles according to their charging state. We confirmed by comparison with stationary charge distributions that the distributions obtained by our method can be used to easily determine the relative variation of particle charging states, although the proportion of particles with a small charge number was quantitatively underestimated. The K-MACS was utilized in Yokohama city (urban area) and Suzu city (rural area) to recode the temporal variation of the particle charging state constantly for approximately two months. Then we compared whether the human and urban environments affect atmospheric particle charging characteristics. The developed K-MACS system and the findings of this study provide useful information on charging characteristics of atmospheric particles in urban and rural regions and may contribute to a new perspective for the prevention and control of air pollution.

9AP.4

Constraining the Particle-Scale Diversity of Black Carbon Light Absorption using a Unified Framework. PAYTON BEELER, Rajan K. Chakrabarty, *Washington University in St. Louis*

Atmospheric black carbon (BC) manifests across a wide spectrum of morphologies and compositional heterogeneity. The distribution of BC among diverse particles of varied composition gives rise to enhancement of its light absorption capabilities by over twofold in comparison to that of pure BC. This situation has challenged the modeling community to consider the full complexity and diversity of BC on a per-particle basis for accurate estimation of its light absorption. The conventionally adopted core-shell approximation is inadequate in not only estimating but also capturing absorption trends for ambient BC. Here, we develop a unified framework which accounts for the complex diversity in BC morphology and composition using a single metric, the phase shift parameter (ρ_{BC}). We systematically investigate the effect of variations in ρ_{BC} across the multi-space distribution of BC morphology, mixing-state, and mass as reported by field and laboratory observations. We formulate universal scaling laws centered on ρ_{BC} and provide physics-based insights regarding overestimation of BC light absorption by core-shell approximations. We conclude by packaging our framework in an open-source Python application to facilitate community-level use in future BC-related research. Our framework thus provides a computationally inexpensive source for calculation of absorption by BC, and can be used to constrain light absorption throughout the atmospheric lifetime of BC.

9AP.5

Cost-Effective Real-Time Sensing of Speciated Fine Particulate Matter Air Pollution Using Advanced Machine Learning Techniques. SINA HASHEMINASSAB, David Diner, Richard Flagan, Meredith Franklin, Michael Garay, Hyung Joo Lee, *Jet Propulsion Laboratory*

A large body of scientific research has demonstrated the strong association between exposure to ambient particulate matter (PM) and a variety of adverse health outcomes. However, the relative toxicity of different PM chemical components is still poorly understood. Due to the high costs and logistical complexities associated with collecting particles on filter media and subsequent offline chemical analyses, speciated PM monitoring is generally conducted at a limited number of locations with low frequency (e.g., every third or sixth day), and the results become available several months after sample collection. The objective of this research is to explore a novel approach for more cost-effective, real-time estimation of $PM_{2.5}$ chemical components (e.g., sulfate, nitrate, organic carbon, elemental carbon, and dust) using advanced machine learning (ML) techniques on a suite of state-of-the-art particle optical scattering, absorption, and size distribution measurements, as well as gas-phase data and meteorological information as compositional PM predictors.

For this project, ambient air quality monitoring is being carried out at Jet Propulsion Laboratory in Pasadena, CA, with the following suite of instruments: time-integrated filter samplers for $PM_{2.5}$ speciation as “truth” in the ML models; a scanning electrical mobility spectrometer (SEMS) and an optical particle counter for full size distribution measurement of particles (10 nm-40 µm); a multi-wavelength aethalometer for particle absorption measurement; a multi-wavelength, multiangular, polarimetric nephelometer to retrieve PM size, shape, and complex refractive index; gas sensors for monitoring of NO_2 and SO_2; and a weather station for measurement of important meteorological parameters (e.g., temperature, humidity, UV index, etc.). The resulting dataset from these measurements is being utilized to train ML algorithms to identify and rank the most capable speciated $PM_{2.5}$ predictors. Determination of which real-time observational parameters are the most effective predictors of speciated $PM_{2.5}$ (and for which species) will establish the design of a conceptual sensor package that could be deployed as a real-time complement to the conventional filter/laboratory analysis-based samplers. In this presentation, we will present a summary of the field measurements carried out thus far and provide preliminary results of the ML models for estimation of $PM_{2.5}$ chemical components.

9AP.6

Characterization of the New UCR Fixed-volume Chamber. QI LI, Thomas Eckel, Chen Le, Huawei Li, Sahar Ghadimi, Ryan W. Drover, Daniel Gonzalez, David R. Cocker III, *University of California, Riverside*

Static electric charges have been identified to be the most critical factor impacting the previous-generation UCR dual collapsible chamber systems with respect to particle-wall interactions. The new generation UCR chamber system (~120 m^3 fixed volume) was finished in 2021. The chamber is suspended, electrically isolated from other surfaces, and equipped with three soft x-ray photoionizers to discharge the chamber before each experiment leading to a highly consistent surface static charge status (surface voltage within ±10V) across experiments. The chamber was measured to have an extremely low PM background of $<0.01\ \mu m^3/cm^3$ after 8 hours of irritation with 2 ppm H_2O_2. Low particle total number decay rates $<2\ day^{-1}$ were achieved with the low static charge and low chamber surface area to volume ratio ($1.22m^{-1}$). An upgraded three-component particle loss correction method was developed and validated to have ~100% recovery rate in pure seed deposition experiments. Detailed characterization of the new chamber will be provided and compared to the UCR dual collapsible chamber system, including geometry, soft x-ray setup configuration, surface charging measurements, UV lights profiles, dilution ratios, etc. Advanced understanding on particle deposition rate and vapor wall loss will be presented as well with discussions on varying factors that can significantly affect vapor wall loss.

9AP.7

Influence of Biomass Burning Events on Aerosol Optical Depth in Sao Paulo, Brazil. MARIA OLIVEIRA, Regina Maura Miranda, *University of São Paulo*

The air quality in the Metropolitan Area of São Paulo (MASP), with more than 20 million inhabitants, 8 million vehicles, as well as the major industrial and technological park of Brazil, is influenced by local sources of pollution, mainly from vehicles and industries, but there is a concern about the role of remote sources in the concentration of particulate matter, such as forest fire events, which occur mainly in the interior regions of Brazil. This study was conducted with the objective of understanding and quantifying the impact of these biomass burning events on air quality in the MASP, investigating the relationship between burning events, aerosols optical depth (AOD), variation in the concentration of PM10 and PM2.5 and surface meteorological conditions, using a database from 2005 to 2021. Days with high AOD were selected, more frequent in September, and related to the increase in the number of fire events in the country. The results indicate that biomass burning events, even occurring hundreds of kilometers away from São Paulo, can reach the region through transport by air masses at high levels in the atmosphere, increasing the concentration of pollutants, mainly aerosols, worsening the surface air quality and being harmful to human health.

9AP.8

Investigation of the Charging State of Radioactive Cs Particles Using Kelvin Probe Force Microscopy. YUKIMI SHINKE, Ayumi Iwata, Keiichi Kurosawa, Makoto Inagaki, Shun Sekimoto, Koichi Takamiya, Yuichi Oki, Tsutomu Ohtsuki, Yasuhito Igarashi, Tomoaki Okuda, *Keio University*

The accident at the Fukushima Daiichi Nuclear Power Plant (FDNPP) in 2011 resulted in the dispersal of water insoluble glassy radioactive Cs-bearing particles . The dispersed radioactive Cs-bearing particles may accelerate deposition inside the airways due to self-charging by radioactivity of the particles and their deposition may have more adverse effects on the human body than formerly understood. However, a method for measuring the detailed electrostatic properties of individual particles collected from the actual environment has not yet been established. Furthermore, no measurements have been made regarding the charged state of the particles generated by the actual FDNPP accident.

In this study, an attempt was made to elucidate the charging state of individual particles using a technique called Kelvin Probe Force Microscopy (KPFM). Experiments measuring the surface electrostatic potential of particles with known charge numbers have revealed that a linearity is established between the number of charges and the surface potential, and that the equation of the linearity depends on substances that make up the particles.

We also calculated the relationship between the number of charges on the single particle and its surface potential by considering the KPFM measurement system as a capacitor. When the particles are completely dielectric, the slope of the calibration curve is not affected by the physical properties of the particles and only the intercept is expected to depend on the chemical? composition of the particles. In contrast, if some of the particles are conductors due to residual moisture, the slope of the calibration curve would be affected by the physical properties of the particles.

Elucidation of the charge state, or charge number, of the radioactive particles whose charge states are unknown could be achieved by measuring the surface potential by KPFM and fitting it to a calibration curve based on the composition of the particles.

9AP.9

Simulation of Air Flow in a Nose-Only Inhalation Exposure System Using Ansys CFD. SEONGGI MIN, Dong-Jin Yang, Jae-Hyun Kim, Susan Chemerynski, Steven Yee, *CTP/FDA*

In vivo inhalation studies frequently use nose-only inhalation exposure systems that are designed for the direct respiratory exposure of laboratory animals to aerosols. An important aspect of these systems is consistent, uniform dosing throughout the exposure period. Currently, the CTP/NCTR Inhalation Toxicology Core Facility uses a 5-tier (50 total ports) nose-only inhalation exposure system in animal studies involving aerosolized tobacco-related constituents. However, due to inhomogeneous pressure distribution within the inhalation chamber, dissimilar aerosol flow rates have been observed across some of the ports in the inhalation exposure system. In air speed measurements, the relative air speed was 67.7% at the top tier and 112.9% at the bottom tier. To resolve this difference, a simulation of the inhalation exposure system was developed using Ansys CFD 17.2 software. In the simulation, a cylindrical shaped rod (crown shaped at the top to minimize air resistance) was inserted into the internal space of the inhalation chamber and a tier without any output ports was added on the top of the exposure system to help equilibrate the pressure distribution. A hot-wire anemometer was used to confirm the accuracy of the measured air speed with the simulated air speed in the inhalation exposure system (i.e., no rod and only 5 tiers) and was found to be similar (±1%). The simulation was then performed with 25 rods with different diameter sizes. The 5 rods with the smallest relative standard deviation of air speed were selected and compared with the results measured by the hot-wire anemometer. Similarity between the simulated and measured air speed was observed, within ±4%. Overall, this work supports the development of homogenous aerosol flow for consistent, uniform animal dosing. Future work will include simulation of aerosol flow and verification of homogenous aerosol flow distribution across the inhalation exposure system.

9AP.10

Simulating Combined Translation and Rotation of Arbitrary Shaped Aerosol Particles using Hamilton's Quaternions. MRITTIKA ROY, Zhibo Liu, Ranganathan Gopalakrishnan, *University of Memphis*

We simulate the trajectory of an arbitrary shaped aerosol particle made up of identical point-contacting spheres in three dimensions considering both translational and rotational degrees of freedom. To model motion in vacuum, we solve Newton’s second law of motion for translation and Euler’s equation for rigid body rotation. To avoid singularities associated with describing the orientation of a shape with Euler angles, we employ a quaternion formulation that leads to eight ordinary differential equations to describe the evolution of the angular position and angular velocity of a rigid body. We perform all the rotational dynamics calculations in the body-fixed frame of reference attached to the rotating shape, whose basis vectors are the normalized eigenvectors of the inertia tensor of the particle. The equations of combined rotation and translation are solved using the fourth-order Runge-Kutta scheme. For validation, computations of the orientation-averaged projected areas for agglomerate pairs are compared with the calculations of Thajudeen et al. (Aerosol Science and Technology, 46:11, 1174-1186). To include particle Brownian motion and hydrodynamic resistance when a particle moves in a gas, a Langevin formulation of the translation and rotation equations is used. We calculate the translational and rotational friction factors for an aerosol particle using the Extended Kirkwood-Risemann method developed by Corson et al. (Physical Review E 96(1): 013110, Physical Review E 95(1): 013103). Previously, Thajudeen et al. developed an expression for the coagulation rate constant between two agglomerates without explicitly considering rotation. Using the developed computational procedure, we are currently investigating the effect of particle rotation on coagulation dynamics.

9CA.1

Impacts of the COVID-19 Pandemic on Ambient Concentrations and Sources of Black Carbon in the United States. Marco Eugene, SANCHITA PAUL, Md. Aynul Bari,
University at Albany, SUNY

Black carbon (BC) is a potent short-lived climate pollutant and an important component of particulate matter emitted from fossil fuel combustion (e.g., diesel engines) and biomass burning (e.g., wood stoves) and has linked to adverse health outcomes. Globally, investigations have shown significant reductions of primary air pollutants such as PM2.5 and NO2, while significant increases of ground-level O3 and secondary particulate matter, as well as almost no significant changes were evident for CO2. To date, no attempt has been made in the United States to understand the effects of COVID-19 pandemic on ambient concentrations of black carbon. The specific objective was to determine the extent to which concentrations and anthropogenic sources of black carbon have changed during the COVID-19 pandemic.

We used available black carbon data for 19 different characteristics sites in 9 U.S. states covering residential, urban city centers, rural and suburban areas. We examined changes in black carbon concentrations during 2020 in relation to 2019 using non-parametric analysis for three different time periods i.e., pre-lockdown, lockdown, and reopening phase. Preliminary results indicated significant decreases in black carbon concentrations during lockdown period in urban city centers (e.g., Washington D.C., New Haven, Fort Lauderdale), while significant increases were also observed in some suburban and rural residential sites (e.g., Saint Petersburg, FL and Smithfield, UT). We evaluated diurnal variation in black carbon and identify local source impacts for different time periods. To identify and quantify changes in both local and regional black carbon sources during the COVID-19 pandemic, positive matrix factorization (PMF) was also applied using black carbon and PM2.5 speciation data. Findings can benefit the general public and the scientific community to improve understanding of COVID-19 impacts on black carbon and motivate them to take actions to reduce their carbon footprint to protect our environment.

9CA.2

Spatiotemporal Analysis of Black Carbon Sources: Case of Santiago, Chile. Jessika Rodriguez, HECTOR JORQUERA,
Pontificia Universidad Catolica de Chile

The use of aethalometers generates useful information on carbonaceous aerosols. Specifically, the aethalometer model provides an apportionment of black carbon (BC) from fossil fuels and wood burning sources. At any given receptor site, this apportionment is aggregated, that is, local and regional BC sources are lumped together in the outcome of the aethalometer analysis. However, for regulatory purposes, it is desirable to have quantitative estimates of both contributions. This is particularly relevant for remote locations or suburban monitoring sites.

We propose a spatiotemporal analysis of BC aethalometer results which is based on ambient measurements of BC fractions (fossil fuel plus wood burning) along with meteorological information. We apply this methodology to BC measurements in three suburban sites surrounding Santiago, Chile. The results show that the methodology can apportion BC_{ff} and BC_{wb} into local and regional contributions. By using PM2.5 – BC_X scatterplots for each spatiotemporal pattern, the associated edge lines show distinctive BC_X/PM2.5 ratios: they are larger for the local sources (fresh emissions) than for the regional contribution (Santiago’s atmospherically processed emissions). These ratios are then used to apportion total $PM_{2.5}$ at each monitoring site.

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9CA.3

PM2.5 Brown Carbon in Water and Methanol Extracts: Measurement and Estimation of Contributions to Fine Particle Light Absorption over Bhopal, Central India.

ANKUR BHARDWAJ, Ramya Sunder Raman, Manju Galodiya, *Indian Institute of Science Education and Research Bhopal*

The light-absorbing properties of water-soluble brown carbon (WS-BrC) and methanol-soluble brown carbon (MeS-BrC) were studied in ambient fine particulate ($PM_{2.5}$) aerosols collected at Bhopal, a regionally representative location in Central India during 2019 and 2020. Particulate organic carbon (OC), elemental carbon (EC), and WSOC were measured by thermal-optical carbon analysis and Total OC analysis method, respectively (349 quartz filter samples; 24-hour time-integrated). Particulate light-absorption was measured with a multi-wavelength thermal-optical carbon analyzer (DRI 2015; 405 - 980 nm), and solution light-absorption spectra of water and the methanol extracts were measured by UV-visible spectrophotometer (Agilent Cary 100/300; 300 - 800 nm). The light absorption coefficients (babs) of WS-BrC and MeS-BrC were highest during the post-monsoon and lowest during the monsoon seasons. MeS-BrC absorbs about 5 times higher at 365 nm and about 4 times more at 550 nm, compared to WS-BrC at these wavelengths. At 405 nm, light absorption by solution BrC on average were 6 ± 5 % (WS-BrC) and 10 ± 4 % (MeS-BrC) of particulate BrC absorption, while they were 4 ± 3 % (MeS-BrC) and 5 ± 2 % (WS-BrC) of particulate EC absorption. The mass absorption cross-section (MAC) of WS-BrC ($1.9 \pm 1.2\ m^2\ g^{-1}$) and MeS-BrC ($2.1 \pm 1.1\ m^2\ g^{-1}$) measured at 365 nm were similar to those observed previously at South and East Asian cities (Delhi, India and Xianghe, China). BrC concentrations in solution show that it is optically important in the near-UV range even during the monsoon season, when no biomass burning emissions occur ($WS\text{-}BrC_{405}$: ~3 ± 0.4 %; $MeS\text{-}BrC_{405}$: ~9 ± 4 % of total $PM_{2.5}$ light absorption).

9CA.4

Alternative Approach for the in-situ Measurement of Absorption Enhancement of Atmospheric Black Carbon Due to Atmospheric Mixing.

ASHISH SONI, Tarun Gupta, *Indian Institute of Technology Kanpur*

The significant uncertainty associated with Black Carbon (BC) radiative forcing estimation is mainly due to discrepancies related to its mixing state. The in-situ measurement-based understanding of absorption properties is limited to only a few locations worldwide, primarily due to the unavailability of sophisticated instrumentations for absorption enhancement (E_{abs}) measurements resulting from mixing with non-BC chemicals. Therefore, we have proposed a novel approach for the measurement of absorption enhancement using a thermal-optical carbon analyzer. In the present study, the absorption spectra during different stages of thermal-optical carbon analysis were used to estimate the absorption coefficients of mixed and pure BC aerosols. Moreover, we have also proposed a more robust approach for apportioning light absorption by BC core and absorbing organics (brown carbon). The present method was applied to ground-based aerosol samples collected at two distinct Indo-Gangetic Plain (IGP) sampling stations. Amongst one is dominated by the primary emissions, while the secondary emissions dominate another station.

The significant outputs and their implications are mentioned below:

(1) The E_{abs} at 808 nm were observed to be approximately 1.2 at both the IGP stations, which is identical to the previously estimated E_{abs} using sophisticated instrumentations in the neighboring IGP station. The result depicted the utilization of the proposed simplified approach for more ground-based aerosol samples will be helpful to reduce the uncertainty of BC absorption due to atmospheric mixing in the earth system models.

(2) The complex mixture of absorbing brown carbon chromophores showed a wide range of absorption in the ultraviolet to near-infrared wavelengths with minimum absorption at 635 nm. Thus, the present study suggests that the absorption of organics in near-infrared wavelengths cannot be neglected.

Note: It is a part of our ongoing research, small portion was also published in ACS Earth and Space Chemistry journal (Soni and Gupta 2022, DOI: acsearthspacechem.1c00362).

9CA.5

Carbonaceous Aerosol Analysis Tool CAAT Software Package For Data Analysis. KLEMEN KUNSTELJ, Matej Zemljak, Matic Ivančič, Asta Gregorič, Martin Rigler, *Aerosol d.o.o.*

Introduction
Carbonaceous aerosols are usually the most significant contributor to fine particulate matter (PM2.5). They are frequently separated into organic carbon (OC) and elemental carbon (EC) based on their volatility using thermal-optical methods.

The Aethalometer model AE33 collects aerosol particles continuously by drawing the aerosol-laden air stream through a spot on the filter tape. It analyzes the aerosol by measuring light transmission at seven wavelengths through one portion of the filter tape containing the sample versus the transmission through an unloaded part of the filter tape acting as a reference area. The Magee Scientific Total Carbon Analyzer, Model TCA08, is a newly developed scientific instrument that measures the Total Carbon Content ("TC") of suspended aerosol particles in near real-time using a simplified thermal method (Rigler et al., 2020).

The combination of Total Carbon Analyzer TCA08 and the Magee Scientific Aethalometer® model AE33 provides a novel approach for measuring TC, eBC, OC, EC, Brown Carbon content of suspended aerosol particles in near-real-time with high-time resolution.

Abstract Review
The CAAT abbreviation stands for Carbonaceous Aerosol Analysis Tool and is a software tool for analyzing data from the AE33 Aethalometer® and the TCA08 Total Carbon Analyzer.

Its main progression tasks are as follows: Import, Validation and Analysis procedures, such as diurnal profiles, Time averages, Absorption coefficient, Angstrom exponent, Attenuation, Source Apportionment, concentration determination of some most relevant carbonaceous aerosol species (Total Carbon, Elemental Carbon, Organic Carbon, Black and Brown Carbon).

With this work, we want to show the importance and capabilities of the newly developed Analytical software to indicate and forecast particular trends and seasonal variations of concentrations of the specific carbonaceous aerosols.

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9CA.6

Implementation of the Reactive Organic Carbon Framework for U.S. Mobile Source Emissions. BENJAMIN MURPHY, Darrell Sonntag, Karl Seltzer, Havala Pye, Claudia Toro, Evan Murray, *U.S. EPA*

Primary particle emissions are conventionally treated as nonvolatile and inert in mobile-source emission models and subsequently in national scale inventories. However, there is clear scientific evidence that the organic component of particle emissions is semivolatile and that primary vapors span a wide range of volatility, with the lower volatility vapors contributing efficiently to formation of SOA (secondary organic aerosol). To account for these complexities, emissions data must be carefully revised with the most recent scientific findings, while ensuring compatibility with existing assumptions. This presentation will discuss the methodology with which we have revised the PM and VOC speciation used by the Motor Vehicle Emission Simulator (MOVES), maintained by the US EPA, and will report the expected impacts on mobile-source emissions for a recent year (2016).

Previous studies have successfully introduced semivolatile POA and intermediate volatility organic compounds (IVOCs) using top-down assumptions for all anthropogenic emissions, the entire mobile sector, or large subsets of the mobile sector (e.g. gasoline vs. diesel vehicles). This effort implements detailed speciation of PM and VOC, including volatility resolution, directly to the detailed emission model output, thus producing the first such dataset for U.S. mobile-source emissions. Twenty-three VOC and fifteen PM profiles have been updated. We will discuss issues related to translating emissions testing results to model-ready inputs including accounting for missing partitioning of POA, interpretation of filter artifacts and ensuring total reactive organic carbon closure. We also report on changes to predictions of hazardous air pollutant emissions from the mobile sector as a result of updates to the VOC speciation.

9CA.7

Application of the Community Regional Atmospheric Chemistry Multiphase Mechanism (CRACMM) to Simulation of Air Quality in the Northeast USA. BRYAN PLACE, Karl Seltzer, Chris Allen, Benjamin Murphy, K. Wyat Appel, Ivan Piletic, Emma D'Ambro, Rebecca Schwantes, Matthew Coggon, Sara Farrell, Emily Saunders, Lu Xu, Golam Sarwar, William Hutzell, William R. Stockwell, Ana Torres-Vasquez, Jonathan Pleim, Havala Pye, *United States Environmental Protection Agency*

The Community Regional Atmospheric Chemistry Multiphase Mechanism (CRACMM) aims to provide a transparent link between the emissions and transformations of reactive organic carbon (ROC) in the atmosphere. As such, one of the main achievements of the mechanism is to couple gas-phase reactions and products with the particle-phase and better represent atmospheric secondary organic aerosol (SOA) formation. In this work, we present an initial evaluation of CRACMM version 1.0 implemented within the Community Multiscale Air Quality (CMAQ) model using the Northeast USA Summer 2018 as the testing domain. We discuss the mechanism performance in context of previously well-established chemical mechanism such as Carbon Bond 6 and RACM2 and evaluate the model outputs against multi-network observations of ozone, organic carbon, particulate matter, and hazardous air pollutants. Box modeling is used to provide insight into how changes in the mechanistic representation of various systems affects the prediction of oxidants and precursors to SOA. We find that the CRACMM mechanistic representation of ROC chemistry including autoxidation, multigenerational oxidation, and treatment of semi-and intermediate volatility compounds produces levels of SOA similar to top-down algorithms. These initial evaluations thus indicate that CRACMM could provide a fully bottom-up replacement for empirical SOA parameterizations in CMAQ that can be used for source apportionment.

9CM.1

Effect of Flow Oscillation on the Loading Performance of Respirator Filter Media. PENG WANG, Da-Ren Chen, *Virginia Commonwealth University*

The particle loading on the filter media of respirators may occur due to the lasting usage of respirators, especially under the current COVID-19 pandemic and dusty working conditions, for examples, mining and civil construction. While a few studies on the effect of human's breathing to the performance of clean respirator filter media have been reported, very limited research has been conducted to study the loading performance of respirators' media under the human's breathing condition. Despite respirator filter media, fibrous filter media used in various applications (i.e., HVAC filter panel, engine inlet filters) experience the oscillating flow conditions during most of their lifetime.

In this study, the instantaneous pressure drops and filtration efficiency of respirator filter media under the particle loading were investigated in the flow condition of both inhalation and exhalation. A flow simulator was utilized to generate the oscillating flow conditions. The filter media were challenged under different oscillating frequencies and compared with the case under the corresponding constant flow rate to investigate the effect of oscillating frequency on the performance of filter media. Both NaCl and Arizona dust (ARD) particles with different size distributions were utilized to study the size effect of particles on the loading performance of the filter media under the flow oscillation. In addition, the effect of exhalation moisture on the loading performance of the filter media was also investigated. The hygroscopicity of challenging particles was considered by utilizing both hydrophilic and hydrophobic particles. Our study shows the flow oscillation may significantly affect the loading performance of respirators' filter media. Our study may provide some guidance to optimize the structure design of the filter media working under the ordinary flow oscillation.

9CM.3

On the Impact of COVID-19 Pandemic Lockdowns on Atmospheric Particulate Matter in the United States.

DEVONNE FRIDAY, *Embry-Riddle Aeronautical University*

The world has been facing a pandemic caused by the COVID-19 virus since early 2020. Community mitigation strategies were implemented in attempts to lower the risk for virus transmission. One such strategy included the issuance of lockdowns requiring persons to stay at home, resulting in reduced mobility and vehicular usage throughout several states. The transportation industry contributes significantly to concentrations of fine particulate matter (PM2.5) into the atmosphere. The COVID-19 lockdowns thus serve as a natural case study, providing an opportunity to better understand the sources and formation of atmospheric PM2.5. The aim of this study is to characterize the impact of the lockdowns associated with the COVID-19 pandemic on PM2.5 concentrations throughout ten states across different regions in the U.S. In addition to the fact that these states were issued stay at home mandates, the states under investigation were chosen to capture diverse ambient, meteorological, and environmental conditions. Furthermore, every chosen state encompasses several monitoring sites, offering reliable historic air quality data. Hourly PM2.5 concentrations and meteorological data were acquired from the U.S. EPA at all sites present at each of the relevant states during 2015 - 2020. Precipitation data is used to eliminate the effect of rainfall on PM2.5 levels. The study period was divided into three periods namely the “Pre-lockdown”, “Lockdown”, and “Post-lockdown” periods based on stay-at-home mandates at each state. To characterize the effect of the pandemic, concentrations of PM2.5 monitored in 2020 are compared to their corresponding historic data provided at the same sites during the same period from 2015 to 2019. Statistical testing is conducted to determine the significance of the changes in the hourly average concentrations of PM2.5 in 2020 compared to their historic averages. This work has implications for regulations of PM2.5 as a criteria pollutant in the U.S.

9CO.2

The Effect of Blending with Octane Boosters on Aerosol Formation in Low-Temperature Combustion of n-Heptane.

OMAR EL HAJJ, Brandon Rotavera, Rawad Saleh, *University of Georgia*

We have previously shown that fuels with two-stage ignition also exhibit two-stage aerosol formation. First-stage ignition is undesirable in spark-ignition engines and is minimized by blending gasoline with high research octane number (RON) blendstocks. Previous studies have reported that some blendstocks blend synergistically or antagonistically for RON, meaning that they produce higher or lower RON, respectively, than predicted by a linear-mixing model.

Here, we investigated whether the low-temperature combustion chemistry governing blending behavior for RON affects first-stage aerosol formation. We used *n*-heptane, a two-stage ignition fuel, as a primary fuel and blended it with three different blendstocks: ethanol, toluene, and 2,5-dimethylfuran (DMF). *n*-heptane is known to blend synergistically with ethanol and DMF, whilst it blends antagonistically with toluene. We conducted combustion experiments in a reactor controlled at constant equivalence ratio ($\varphi = 1$) and $O_2/N_2 = 0.1$, and at temperatures between 250 °C and 600 °C to capture the first-stage ignition region. We measured the aerosol size distributions to calculate aerosol emission factors (EF) for each blendstock at different blending ratios.

The peak EF of pure *n*-heptane was 600 mg/kg-fuel, while the pure blendstocks exhibited no first-stage aerosol formation (EF = 0). At 50% mole fraction, blending with toluene reduced EF to 330 mg/kg-fuel, slightly higher than predicted by a linear-mixing model (300 mg/kg-fuel). On the other hand, blending at 50% with ethanol and DMF reduced EF to 60 and 18 mg/kg-fuel, respectively. These results indicate that synergistic blending for RON leads to more efficient suppression of first-stage aerosol compared to antagonistic blending. Blending with DMF led to stronger reduction in first-stage aerosol compared to ethanol, which is in-line with previous reports on DMF being a superior RON booster and indicates that certain biofuel additives can simultaneously enhance ignition characteristics and reduce aerosol formation.

9CO.3

Mechanisms of Soot Aggregate Restructuring and Compaction. JOEL CORBIN, Robin Modini, Martin Gysel, Timothy Sipkens, *Paul Scherrer Institue*

Soot aggregates form as open, fractal-like structures, but aged atmospheric particles are often observed to be restructured into more compact shapes. This compaction has a major effect on the radiative properties of the aggregates, and may also influence their aerosol-cloud interactions and toxicity. Recent laboratory studies have presented conflicting arguments on whether this compaction occurs during condensation or during evaporation. In this three-part study, we combine theory and experiments to explain these conflicting results. First, we review the surface-science literature and identify explicit mechanisms condensation compaction as well as evaporation compaction. We also identify a mechanism for avoiding compacting during condensation, which is predicted from heterogeneous nucleation theory and the kinetic barriers to capillary formation. Second, we review the soot-restructuring literature and find evidence for all of these compaction mechanisms, the most common being condensation-compaction. Some atmospheric studies have reported non-compacted soot in internal mixtures, which we attribute to coagulation, and which is less common. Third, we present new experimental results from a study in our laboratory where the surface tension of anthracene coatings was switched on or switched off by using solid or liquid phases during addition and removal. Consequently, we demonstrated condensation compaction, evaporation compaction, and no compaction, for the same soot source. Overall, our study indicates that it is most reasonable to assume that soot will undergo compaction upon coating condensation in the atmosphere, in combustion systems, and in human lungs. This presentation will also include a discussion of the effective density of compacted soot aggregates.

9CO.4

Determination of Potential Genotoxicity Effect in Male Wistar Rats Exposed to Gasoline Generator Emissions. GODSON ANA, Oluwayemisi Adeegbe, Solomon Owumi, *University of Ibadan*

Background. Over the years exposure to air pollution from combustion processes have been linked to an array of public health disorders. However, the mechanisms associated with the genotoxic effect have not been exhaustively elucidated. This study assessed the levels of gasoline generator emission (GGE) and genotoxicity endpoints using rat models.

Methodology. A laboratory based experimental design was employed. An environmental chamber was designed using clear thermoplastic to house the rat during exposure to 0.5KVA GGEs. A pilot test was first carried out using eight experimental rats to establish a baseline LC50 which was obtained at 40 minutes. Three experimental groups of eight rats each were then subjected to 5, 10, 15 minutes exposure per day for fourteen days between the hours of 10 and 11 am. A fourth group of eight rats was kept as control and given the same treatments as experimental groups except for the exposure to GGEs. Level of CO and PM2.5 in the chamber were recorded simultaneously using the appropriate samplers and compared with guideline limits.

Results.Twenty-four hours after the completion of the fourteen days exposure the micronucleus frequency significantly increased (p=0.000) with increase in exposure time, group 1 having the highest frequency of 1.34±0.23 and the control group had the lowest frequency of 0.11±0.05. Exposure to GGEs at non-lethal concentration in a sub-acute or chronic manner was found to have morphological and genotoxic effects in rats which may likely occur in man under similar conditions.

Conclusion. Therefore, use of exhaust filter and improvement in the ventilating systems in houses is encouraged to reduce pollution load from generator emissions.

9CO.5

Effect of Maturity on the Measurements of Soot Volume Fraction by the Auto-compensating Laser-induced Incandescence Technique.

FENGSHAN LIU, Jerome Yon, Felipe Escudero, Andrés Fuentes, Timothy Sipkens, Joel Corbin, Gregory Smallwood, *National Research Council Canada*

Soot is a major byproduct of incomplete combustion of hydrocarbon fuels and biomass burning. Soot is also commonly known as black carbon after emissions. Accurate measurements of soot concentrations at the exhaust of combustion systems are of great importance for emission control and assessing the effectiveness of combustion and fuel technologies on soot emission reduction. Laser-induced incandescence (LII) has been found widespread use for measurements of carbonaceous and metal nanoparticles in many different applications.

The auto-compensating LII (AC-LII) technique has become one of the popular in-situ real-time optical method for both in-flame and exhaust soot measurement. In AC-LII, the absolute LII signals at two different spectral bands in the visible to near-infrared are detected and the laser-heated soot particle temperature is determined through the principle of two-color pyrometry. Then the soot volume fraction can be inferred from the soot temperature and one of the two LII signal. In the current AC-LII data analysis, it is implicitly assumed that the soot to be measured is mature and the absorption functions at the two detection wavelengths are equal. Recent studies have revealed that soot emitted from difference combustion sources displays size-dependent absorption property, an indication that soot emitted from different sources may have different maturity. Soot maturity can be characterized by the Angstrom absorption exponent and less mature soot displays a wavelength-dependent soot absorption function. Neglect of the wavelength-dependent soot absorption function results in overestimation of soot temperature and hence underestimation of soot volume fraction.

In this study, the effect of soot maturity on AC-LII measured soot volume fraction was analyzed and quantified by comparing the AC-LII measurements with light extinction measurements in a laminar coflow diffusion flame.

9CO.6

Climate and Health Implications of Adopting Modern Household Cooking Fuels on a Global Scale.

EMILY FLOESS, Katherine Landesman, Annelise Gill-Wiehl, Rob Bailis, Elisa Puzzolo, Dan Pope, Andrew Grieshop, *North Carolina State University*

2.8 billion people in low- and middle-income countries (LMICs) cook and heat using solid fuels, resulting in 2.6 million deaths annually from illnesses related to poor household air quality driven by particulate matter (PM). Combustion of solid fuels also emits short-lived climate forcers (SLCFs) including black carbon (BC), aerosol precursors and greenhouse gasses that contribute to climate warming. Liquified Petroleum Gas (LPG) and electricity are cleaner alternatives to traditional cooking fuels. We compare the emissions and climate impacts of residential cooking fuel adoption based on business as usual (BAU) and four transition scenarios of modern fuel use projected to 2040 for 77 countries with more than 1 million people cooking with solid fuels. We account for use-phase and upstream emissions and calculate climate impacts/benefits using a reduced form global climate model to calculate temperature differences associated with different scenarios, including a full transition (FT) to LPG and electricity. A FT to LPG and electricity results in significant health benefits with a 6.39 Mt (99%) reduction of PM2.5 by 2040. The reduction in climate forcers by 2040 results in a 6 milli C global temperature reduction compared to the projected overall 1.5 °C increase. Shifting from biomass-heavy to a fossil fuel-heavy cooking scenario results in a large decrease of SLCFs, with a .99 MT (99%) decrease of BC and 5.87 MT (82%) reduction in CH4, and a more moderate decrease in CO2 emissions (reduction of 122 MT, 13%) due to the relatively high CO2 upstream emissions. The biggest reduction in pollutants in a FT is for Subsaharan Africa, due to the high projections of PM2.5 and BC from charcoal use in the BAU scenario. These results help quantify the impacts of rapid scaling LPG and electricity for cooking needs in developing countries.

9EI.1

Understanding the Biology of the Air: The NSF Biology Integration Institute, Regional OneHealth Aerobiome Discovery Network (BROADN). Susan VandeWoude, Sonia Kreidenweis, Kenneth F. Reardon, Angela Bosco-Lauth, Eugene F. Kelly, Tami Bond, Brad Borlee, Amy Charkowski, PAUL DEMOTT, Noah Fierer, Jan Leach, Sheryl Magzamen, Jessica Metcalf, Stephen Reynolds, Joshua Schaeffer, Jane Stewart, Pankaj Trivedi, Diana Wall, Stephen Archer, Susannah Tringe, Jeni Cross, Erin Doyle, Amaya GarciaCostas, Franziska Sandmeier, Shirley Vincent, *Colorado State University*

The aerobiome – defined as microscopic organisms inhabiting the atmosphere – plays important roles in ecosystem diversity and health, disease outbreaks, and potentially the Earth's hydrologic cycle. Unlike the microbiomes of humans, animals, plants, and soil, and despite significant advances in the field of aerobiology, there has been little systematic exploration of aerobiome composition and its variations in space and time as these relate to the terrestrial microbiomes that shape it.

Launched in late 2021, the NSF-supported Biology Integration Institute: Regional OneHealth Aerobiome Discovery Network (BROADN) brings together experts across disciplines to address the overarching question: What is the structure and function of the aerobiome, and how does it interact with terrestrial ecosystems?

To address this overarching question, we identify the following science questions:

(1) What microscopic organisms make up the aerobiome, and how do they vary over time and space? We are optimizing aerobiome sampling and analytical technologies to allow unprecedented characterization of aerobiome components in six unique regional ecosystems surrounding the Front Range of Northern Colorado. A key strategy is to leverage the infrastructure at NSF NEON (National Ecological Observatory Network) for our observations.

(2) Where does the life in the aerobiome come from, and how does composition respond to disturbances? Our studies seek to determine how aerobiome composition is influenced by continuous or intermittent terrestrial disturbances, including fire, drought, urbanization and intensive agriculture.

(3) What physical and biological properties govern movement of microscopic organisms between terrestrial reservoirs and the aerobiome? In this aspect of the work, we will address the key biological and physical properties enabling organisms to become airborne, and will develop new methodologies to measure the fluxes of biological particles to the atmosphere.

(4) Which traits allow microscopic organisms to become aerosolized, transported, and result in ecosystem impacts? We seek to identify and characterize key microbial players and processes, the microbial metabolic and signaling interactions taking place, and the genes and molecules driving aerobiome-ecosystem interactions.

BROADN seeks to expand our understanding of the aerobiome, including its content; its response to weather patterns, anthropogenic disturbances, and physical forces; the characteristics that lead to lofting, transport, and survival of microbes; and metabolic activity and genetic attributes of aerosolized microbes. BROADN employs an integrated approach including representative sampling of aerobiome states and fluxes; bioinformatics linking functionality to molecular and genetic characteristics; and linking these functions to impacts on terrestrial ecosystems. Examples of impacts of the aerobiome to be explored include airborne transport of animal and plant pathogens; ice nucleation and precipitation formation; and global microbial transport related to wildfires.

9EI.2

Organic Composition of Aerosol Particles Generated from the Wear of Automotive Brake Pads. ADAM THOMAS, Maxwell Lee, Véronique Perraud, Lisa Wingen, Paulus Bauer, Michelia Dam, Barbara Finlayson-Pitts, James Smith, *University of California, Irvine*

Electrification and the further adoption of alternative fuels in the coming decades will likely reduce pollution from vehicles significantly, but certainly not entirely. Emissions from non-tailpipe sources, such as from brake and tire wear, are known to contribute to particulate pollution. It is therefore critical to understand the chemical nature of these pollutants to better inform future environmental monitoring and emission control strategies. Crucial to this effort is the identification of potential marker compounds that can be tied to specific processes such as the heating of automotive brake pads. Here, we characterize the molecular composition of particles generated from brake wear. Particles studied include those created from frictional heating by using a custom built brake dynamometer, heating independent of friction (thermal degradation), and atmospheric oxidative aging by mixing freshly generated brake wear aerosol with ozone in a flow tube reactor. Bulk aerosol particles from these experiments were collected on filters and analyzed using an ultrahigh resolution Orbitrap mass spectrometer coupled to an UHPLC platform. Size-selected nanoparticles (sub-100 nm in diameter) were also collected and analyzed in real time using a Thermal Desorption Chemical Ionization Mass Spectrometer (TDCIMS). Observations from thermal degradation experiments, in which brake pads were heated to temperatures representative of normal use, suggest the presence of a rich diversity of oxygenated organic compounds. Some of these compounds were found to absorb UV light, as indicated by photodiode array detection. Nanoparticle composition as observed by TDCIMS further implicates the abundance of oxidized organics in these brake particles. These observations will allow us to assess the extent to which brake wear emissions contribute to particulate pollution within local communities disproportionally affected by traffic emissions.

9EI.3

Chemical Composition of Secondary Organic Aerosol Produced from the Oxidation of Representative Volatile Chemical Products. LU XU, Matthew Coggon, Chelsea Stockwell, Carsten Warneke, Allison Piasecki, Ann M. Middlebrook, Abraham Dearden, Shantanu Jathar, Cort Zang, Tucker Melles, Megan Willis, Katelyn Rediger, Delphine K. Farmer, *CU CIRES - NOAA ESRL*

Volatile chemical products (VCPs) are emerging pollutants that have critical implications on ozone and particulate matter pollutions. However, a quantitative understanding of the contribution of VCPs to ambient particulate matter is lacking, because of uncertainties in the yield and chemical composition of organic aerosol produced from the oxidation of VCPs. In this study, we performed laboratory experiments using the chamber facility at Colorado State University to investigate the oxidation mechanisms, yields of secondary organic aerosol, and chemical composition of several representative VCPs. To simultaneously characterize both gas and particle compositions, a suite of state-of-the-art instruments was deployed, including PTR-MS, FIGAERO I- CIMS, AMS, EESI-MS and two NH4+ CIMS, one of which is coupled with an evaporative aerosol inlet to measure real-time particle composition. This presentation will focus on the gas/particle partitioning characterized by the two NH4+ CIMS and the comparison of particle composition measured by NH4+ CIMS and FIGAERO I- CIMS.

9EI.4

Production of SOA from Hydroxyl Radical Oxidation of Two Cyanobacterial-derived BVOCs, Geosmin and 2-Methylisoborneol.

HALEY E. PLAAS, Jin Yan, N. Cazimir Armstrong, Hans W. Paerl, Jason Surratt, *UNC Chapel Hill*

Several studies have examined the production, transport, and atmospheric fate of biogenic volatile organic compounds (BVOCs) emitted from marine phytoplankton, but BVOCs produced by freshwater algae are largely overlooked. Particularly, bloom-forming, harmful cyanobacteria are known to produce a suite of volatile metabolites, including geosmin (GSM) and 2-methlyisoborneol (2-MIB), an irregular sesquiterpene and monoterpene, respectively. GSM and 2-MIB are commonly tested for in water supplies, but their fate in the atmosphere is unknown. Hydroxyl radicals (·OH) are one key atmospheric oxidant which react rapidly with VOCs to form secondary gases and organic aerosols, which impact climate and human health. To investigate this pathway, we oxidated both GSM and 2-MIB via ·OH and observed the size distribution, concentration, and chemical composition of the secondary organic aerosol (SOA) produced. In separate triplicate trials, GSM and 2-MIB reacted with ·OH at a relative humidity of 50% in a Potential Aerosol Mass Oxidative Flow Reactor (PAM-OFR) for 30-38 days of equivalent atmospheric ·OH exposure. Conditions in the PAM were selected to mimic conditions in the southeastern United States during summertime when cyanobacterial blooms are most common. Real-time particle mass and number concentrations were measured using a scanning mobility particle sizer, and nucleation events were observed following the oxidation of both cyanobacterial-derived BVOCs, with mass concentrations of ~80 µg m^{-3} for GSM and ~200 µg m^{-3} for 2-MIB. SOA chemical composition was measured by impacting particles onto a Teflon filter for offline analysis using reverse phase liquid chromatography coupled with electrospray ionization high-resolution quadrupole time-of-flight mass spectrometry (RPLC/ESI-HR-QTOFMS). Filters are currently being analyzed for chemical constituents of SOA produced and SOA formation pathways are being proposed. We anticipate the molecular-level SOA constituents identified may serve a potential chemical tracers needed for source apportionment of SOA particles derived from harmful cyanobacteria in freshwater systems.

9EI.5

The Role of Phase-state for Deposition of Per- and Polyfluoroalkyl Substances (PFAS).

EMMA D'AMBRO, Benjamin Murphy, Jesse Bash, Havala Pye, *U.S. Environmental Protection Agency*

Per- and polyfluoroalkyl substances (PFAS) are a class of man-made compounds whose emissions to air may contribute, via transport and deposition, to concentrations in surface water, ground water, and private well water in the vicinity of large point sources. Air quality modeling techniques can be used to quantify air concentrations and deposition fluxes to help parse the role of exposure pathways such as direct inhalation and ingestion via contaminated water. We apply the Community Multiscale Air Quality model (CMAQ) version 5.3.2 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 23 PFAS with the largest emissions by mass are identified and added explicitly to CMAQ, along with an aggregate “other PFAS” species to represent the balance of the emissions. An updated deposition parameterization (Surface Tiled Aerosol and Gaseous Exchange, STAGE) is utilized along with estimated chemical properties for each species to simulate the deposition flux to specific, sub-grid land surface types. Thus, the updated model (CMAQ-PFAS) captures the dynamic transformations and removal processes that affect the extent of atmospheric transport of PFAS. Herein, we test the sensitivity of our results, primarily the predicted air concentrations and deposition rates, to the level of detail in our speciated emissions inputs. We find that the chemical specificity is important for accurate physicochemical properties which determine phase state and thus deposition rates of PFAS. We provide recommendations for future chemical transport modeling studies of PFAS.

Disclaimer: The views expressed in this presentation are those of the authors and do not necessarily reflect the views or policies of the U.S. EPA.

9EI.6

Machine Learning-Enhanced Chemical Characterization of Organic Emissions from the Coastal Ocean. EMILY FRANKLIN, Sarah Amiri, Daniel Crocker, Clare Morris, Kathryn Mayer, Jon Sauer, Robert Weber, Christopher Lee, Francesca Malfatti, Christopher Cappa, Timothy Bertram, Kimberly Prather, Allen Goldstein, *University of California, Berkeley*

The organic composition of coastal sea spray aerosol is important for both atmospheric chemistry and public health but is highly complex and incompletely characterized. Coastal waters contain organic material derived from both anthropogenic sources such as polluted runoff and shipping waste, as well as biological sources including algal blooms. In this work we present a speciated chemical analysis of the composition of the organic fraction of sea spray aerosol over the course of the 2019 SeaSCAPE mesocosm experiment. In this experiment, a phytoplankton bloom was facilitated in natural coastal water from La Jolla, California. We apply untargeted two-dimensional gas chromatography to characterize submicron sea spray aerosol samples, reporting 754 unique organic compounds that are traced over a 19-day phytoplankton bloom experiment. Over 80% of these compounds are not listed in mass spectral databases and cannot therefore be definitively identified. A machine learning-based model, Ch3MS-RF, is instead utilized to predict properties of unidentifiable compounds and orient them in chemical properties space. When tested on the identifiable sea spray aerosol components, Ch3MS-RF predicts carbon number with an out-of-sample R^2 (OSR^2) of 0.80 and predicts average carbon oxidation state with an OSR^2 of 0.69, enabling a population-based analysis of compositional shifts in Kroll diagram space. Compounds are also grouped into clusters of similar temporal variability by dynamic time warping hierarchical clustering. Categorization and quantitative compositional analysis reveal three major findings. First, anthropogenic species made up at least 30% of total submicron nascent sea spray aerosol organic mass under pre-bloom conditions, with personal care products contributing particularly highly immediately following water collection. Second, biological activity drove large changes within the carbon pool, transforming primary anthropogenic chemicals and creating novel biogenic chemicals. Third, biogenic marine organics are underrepresented in mass spectral databases in comparison to marine organic pollutants.

9EI.7

Morphology and Hygroscopicity of Nanoplastics in Sea Spray Determined by Humidified Tandem Differential Mobility Analysis Coupled to High-Resolution Time-of-Flight Aerosol Mass Spectrometry. SARAH PETTERS, Eva Kjærgaard, Freja Hasager, Andreas Massling, Marianne Glasius, Merete Bilde, *Aarhus University*

The environmental detection, fate, and transport of micro- and nanoplastics is becoming a topic of great interest in environmental chemistry, atmospheric chemistry, and public health. The presence of microplastics (diameter < 5 mm) in living tissue suggests a strong potential for numerous adverse health effects. Plastic particles accumulate in the ocean and recent works suggest that they can be transferred to the air with sea spray through wave-breaking action. The role of airborne nanoparticles (diameter < 1000 nm) in atmospheric chemistry and public health is largely controlled by particle size, morphology, and surface composition and coatings. Size-resolved aerosol mass spectrometry provides real-time characterization of submicron atmospheric particles. However, the analysis of nanoplastics in complex aerosol mixtures such as sea spray is severely limited by challenges associated with the detection limit of the instrument as well as the high background signal of the aerosol matrix. In this work we characterize the internal and external mixing state of sea spray aerosols spiked with nanoplastics. A humidified tandem differential mobility analyzer is used as a size and hygroscopicity filter, separating the nanoplastics from the sea spray, and an inline high-resolution time-of-flight aerosol mass spectrometer is used to characterize particle composition and internal mixing state. Aerosol from both synthetic and near-shore samples was internally and externally mixed. Aerosol enrichment and coating have a profound impact on aerosol hygroscopic water uptake and humidified size distributions, impacting aerosol efficiency in nucleating cloud drops and the oxidative aging of the particles. This work broadly contributes to the growing understanding of the detection, morphology, and hygroscopicity of micro- and nanoplastics in the lower atmosphere and their impact on the environment and the earth system.

9ID.1

Face Mask Fit Modifications to Reduce the Expulsion of Respiratory Aerosols. FRANCOISE BLACHERE, William Lindsley, Raymond Derk, Jayme Coyle, Angela Lemons, Matthew Duling, Brenda Boutin, Theresa Boots, James Harris, Donald Beezhold, John Noti, *National Institute for Occupational Safety and Health*

Wearing a face mask or respirator to protect others from potentially infectious respiratory aerosols and droplets, called source control, can help limit the transmission of COVID-19. The efficacy of a face mask at blocking expelled respiratory particles depends on how well it fits the user's face. To improve the fit of a face mask and minimize face seal leaks, fit modifications have been proposed but the data on source control are limited. Using manikin-based respiratory simulations, the efficacy of face masks at blocking expelled aerosol particles was examined. The mass and size distribution of particles that pass through or around different face masks were measured by aerosol impactors and optical particle sizers. Medical masks without fit modification blocked up to 57% of aerosols ≤3.3 µm in size. Improving the fit of a medical mask with an elastic brace, knotting the ear loops and tucking in excess material, or adding a cloth mask over the medical mask (double masking) increased the blocking efficacy for smaller sized aerosols. Results show that double masking or using the knot and tuck fit modification blocked up to 83% of cough aerosols and 92% of exhaled aerosols ≤3.3 µm in size. The most notable results were demonstrated with the face mask brace modification, where ≥99% of expelled aerosols were blocked. Simulated exposure studies, where particles were exhaled by a masked source simulator and the mass of the particles reaching the mouth of an unmasked recipient breathing simulator was measured, further demonstrate that a well-fitted face mask can limit recipient exposure. Aerosol exposure was reduced by nearly 100% when the source wore a medical mask fit modified with an elastic brace. The results of these studies highlight personal measures that can be taken to reduce the transmission of respirable airborne pathogens and are not limited to SARS-CoV-2.

9ID.3

Potential Long Term Exposure to Indoor Volatile Organic Compounds from Disinfecting Wipes. HAN N. HUYNH, Runzeng Liu, Qifan Liu, Jonathan Abbatt, *University of Toronto, Canada*

The COVID-19 global pandemic has led to a significant increase in the use of disinfecting personal and household care products, such as hand sanitizers, air cleaners, and wet wipes. Both businesses and residential settings have deployed various sanitizing methods to minimize the risk of COVID-19 infection. A common method is the use of commercially available wet wipes to disinfect frequently used surfaces. However, whether people are exposed to potentially harmful irritants from disinfecting wipes, as well as how long these species remain on the cleaned surface, are not well-studied. The goal of our experimental study is to: i) identify and ii) study the temporal profiles of organic compounds that both off-gas from wiped glass surfaces and remain on the surfaces for extended time periods. Specifically, in addition to hypoallergenic wipes and those marketed as 'clean' wipes, we analyzed common commercial disinfecting wipes whose active ingredients are: citric acid, benzethonium chloride, dimethyl benzyl ammonium chloride, ethyl alcohol. Using a proton-transfer-reaction, high-resolution time-of-flight mass spectrometer (PTR-ToF-MS), we performed in situ measurements of desorbed VOCs and SVOCs from both freshly wiped glass surfaces and those that had aged in room air over a 20-hour period. Molecular speciation was aided by using an online gas chromatograph coupled to the PTR-ToF-MS. As well, by using direct analysis in real time mass spectrometry (DART-MS), we detected very large numbers of organic compounds remaining on the glass surfaces over the same time range. As expected, the decays of VOCs after wiping are faster than SVOC decays, as observed using both the PTR-MS and DART-MS. However, the majority of wiping signals observed by DART-MS, from roughly m/z 200 to m/z 1000, remain on the surface with minimal change for at least 24 hours. By evaluating the desorption rate of the identified VOCs and SVOCs, we can better evaluate long term human exposure to potentially harmful organic compounds from the use of increasingly commonly used disinfecting wipes. In particular, exposure will occur via inhalation of gases and by dermal contact. As well, SVOCs will partition to ambient aerosols, increasing the importance of the inhalation exposure pathway.

9ID.4

Evaluation of PM2.5 in Indoor and Outdoor Orchestra Setting Using Low-Cost PM Sensor Network during Live Orchestra Performance. SHRUTI CHOUDHARY, Stephen Liang, Pratim Biswas, *University of Miami*

With the onset of the COVID-19 pandemic, the airborne transmission of viral particles had raised significant concerns regarding the safety of musicians and audiences during musical activities involving playing wind instruments. Currently, there is a lack of real-world data showing the change in particle concentration while playing wind instruments during live orchestra performances that relate to particle emission while playing wind instruments. In this study, we collaborated with St. Louis Symphony orchestra (an indoor setting) and the MUNY (An outdoor, semi-indoor setting) to study the change in particle concentration on a real-time scale using a network of low-cost particulate matter (PM) sensors. Large PM data sets were recorded in different orchestra configurations- a). Indoor vs. Outdoor configuration, b) Position of instruments in the orchestra, c) Woodwind instrument performance vs. brass instruments performance. We found that changes in particle concentration highly depend on the duration of the instrument being played along with the articulation level. We also found that appropriate ventilation in indoor spaces can reduce the time of aerosol lingering in the air. Moreover, the use of partitions in an orchestra setting was also evaluated for the protection of musicians and the audience from the brass wind instrument aerosol emissions. Overall, the findings of this study can provide insights into infectious aerosol risk analysis, and aerosol mitigation strategies for the protection of musicians and a larger audience. Additionally, this study also suggests the use of low-cost PM sensors to address the issues of airborne transmission of infectious diseases in environments where sophisticated particle measuring instruments cannot be used [1,2].

[1] Prakash, J., et al. Journal of the Air & Waste Management Association,71(11), pp1347-1360, 2021.
[2] Choudhary, S., et al. Journal of Infection control and hospital epidemiology, in press, 2022.

9ID.5

The Filtration Efficiency of Surgical Masks for Expiratory Aerosol and Droplets Generated by Vocal Exercises. Alicja Szczepanska, Joshua Harrison, Justice Archer, LAUREN MCCARTHY, Brian Saccente-Kennedy, Ruth Epstein, James Calder, Jonathan P. Reid, Bryan R. Bzdek, *University of Bristol*

The COVID-19 pandemic has increased interest in quantifying the effectiveness of different types of face coverings. Surgical face masks can help reduce the transmission of respiratory diseases, but there is still uncertainty about their efficacy to control emission of respiratory aerosols and droplets. This contribution presents measurements of respiratory aerosol and droplets generated during breathing, speaking and selection of voice therapy exercises both with and without surgical masks. A unique feature of this study is that the measurements were performed across a human cohort consisting of 15 healthy adults. The measurements were carried out in a laminar flow operating theatre, with a near-zero background aerosol concentration. Participants were instructed to perform a respiratory activity and aerosols or droplets were sampled both in front of and to the side of their face. Aerosols were sampled through a funnel into aerodynamic and optical particle sizers (APS and OPS), allowing quantification of the number concentrations, size distributions, and mass concentrations of 0.3-20 µm aerosols. Larger respiratory droplets (>20 µm) were quantified using a water-sensitive paper approach. For all activities, surgical masks reduced the emission of aerosols and droplets. The filtration efficiency at mitigating the aerosols and droplets depended on the size of the particles as well as the type of activity performed. The overall aerosol filtration efficiency by number for a surgical mask measured in front of the participant was >90%. The droplet filtration efficiency was ~100%.

9ID.6

Influence of Human Activities and Occupancy on Emissions of Indoor Particles and Their Potential Contribution to Fomites. P. S. GANESH SUBRAMANIAN, Joseph V. Puthussery, Yuqing Mao, Thanh H. Nguyen, Ty Newell, Vishal Verma, *University of Illinois Urbana-Champaign*

Airborne transmission is probably one of the dominant factors responsible for the widespread infections of SARS-CoV2. Crowded indoor spaces with inadequate ventilation or filtration are vulnerable and can potentially become an infection hotspot. Identifying the dominant factors that influence indoor particle emissions would help in improving our understanding of airborne transmission of pathogens.

In the current study, particle emission rates (PER) and CO_2 exhalation rates (CER) from different human activities for masked (N-95) and unmasked conditions were determined in a sealed chamber. To relate these results with the real-world human-occupied indoor environments, particle number concentration (PNC) and CO_2 were measured in two different environmental settings - a café and a music club, and the influence of human occupancy and other activities on the PER were assessed.

Results showed that both CER and PER were the highest during exercise. There was no statistically significant difference in CER or PER between reading and idle sitting. Interestingly, masking showed a relatively lower CER, indicating CO_2 retention in the mask dead volume, that could mix with inhaled air and thus could also lower O_2 inhalation efficiency. Only during exercise, PER reduction from masking was observed, indicating that the particle emissions from respiration constitute only a tiny fraction of the total particle emissions from humans. Both PNC and CO_2 showed strong-to-moderate correlation with human occupancy in both the club and café. Splitting the dining hours into breakfast and lunch hours significantly enhanced the correlation of PNC with occupancy, indicating that cooking is the dominant source of particle emissions. Collectively, our results from both clean chamber and crowded indoor environments show that humans and human-related activities (e.g. cooking, resuspension) are the dominant sources of particle emissions and that even in complex settings such as restaurants and clubs, PNC could be used as an indicator of human occupancy. Finally, we used this data to model the contribution of these particles towards the fomite generation. The preliminary results suggest significant contribution of the particles emitted from humans to become fomites at high indoor PNC, by escaping the respiratory deposition from infected individuals.

9ID.7

Development of an Environmental Monitor for Real-Time SARS-CoV-2 Detection. JOSEPH V. PUTHUSSERY, Nishit Shetty, Benjamin Sumlin, Dishit Ghumra, Carla M. Yuede, John Cirrito, Rajan K. Chakrabarty, *Washington University in St.Louis*

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is a strain of coronaviruses that causes coronavirus disease 2019 (COVID-19). Air-born transmission of SARS-CoV-2 is widely accepted as a high-risk transmission route for the spread of COVID-19. However, with the recent dip in the COVID-19 cases, several states in the USA and countries across the globe are moving to eliminate mask mandates in schools and public spaces. Therefore, there is an urgent need for a real-time airborne SARS-CoV-2 virus detector that can be placed inside schools and public auditoriums to screen the air to ensure a safe indoor environment for the occupants.

We developed a novel real-time environmental monitor to detect SARS-CoV-2 particles in ambient air. The environmental monitor comprises a wet cyclone-based particle into liquid sampler (PILS) coupled to a micro-immunoelectrode (MIE) technology based biosensor virus detection unit. The aerosols entering the PILS get deposited on the inner walls of the cyclone using the centrifugal forces acting on the incoming aerosols. The ambient particles are directly collected in a phosphate-buffered saline (PBS) solution. After five minutes of sampling, the concentrated particles collected inside the PILS are transferred to the virus-detection unit using an automated liquid delivery system for final virus detection. The virus detection is achieved using a nano-body-based electrochemical biosensor that selectively detects SARS-CoV-2 virions via the spike protein and has a detection limit of 50 viral particles/sample. The sensor provides instantaneous results that allow us to perform continuous near-real-time SARS-CoV-2 detection. The unit also has an inbuilt automated HOCl disinfection feature that ensures safe handling and operation of the environmental monitor, during ambient air monitoring. Here, we will be presenting the design, operation principle, and field sampling results obtained using our SARS-CoV-2 environmental monitor.

9ID.8

Detection of SARS-CoV-2 Aerosols in Testing Clinics. SARAH J. STEIN, Ashley R. Ravnholdt, Vicki Herrera, Danielle Rivera, Paul Williams, Joshua Santarpia, *University of Nebraska Medical Center*

The COVID-19 pandemic has highlighted the potential hazards to workers with jobs that routinely interact with the public. Healthcare workers involved in administering the large quantities of diagnostic testing procedures that have been needed to monitor the progress of the pandemic. Therefore, the diagnostic testing environment represents an opportunity to study risk to public facing workers where the number of positive individuals they interact with is known. Aerosol and surface samples were collected from locations within two Nebraska Medicine COVID-19 testing and vaccine clinics, one located in a converted medical office and one in a converted grocery store. SARS-CoV-2 aerosol was detected in numerous samples and was positively correlated with clinic operation and infection, particularly clinic traffic and waiting room locations. Aerosol detection was shown to be more reliant on independent exposure events than the ratio of positive patients to total clinic traffic, suggesting that individual viral shedding is the predominant cause of SARS-CoV-2 aerosol presence. Additionally, extended duration aerosol sampling was shown to be more effective at SARS-CoV-2 detection, and SARS-CoV-2 was confirmed to be transmitted via submicron aerosol particles.

9ID.9

Robust Measurement of Particle Filtration Efficiencies: Evaluated Quantities and Experimental Sensitivities. TIMOTHY SIPKENS, Joel Corbin, Gregory Smallwood, Andrew Oldershaw, Ian Leroux, Jalal Norooz Oliaee, Fengshan Liu, Thierry Lavoie, Triantafillos Koukoulas, Richard Green, Prem Lobo, *National Research Council Canada*

The COVID-19 pandemic has led to a resurgence of academic studies and new standards targeting respiratory protection. Many academic studies and standards differ in the measured quantities – for instance, whether they employ size-resolved (mostly scientific studies), number-weighted (e.g., in the ASTM F2299 test method), or mass-weighted (e.g., in the NIOSH TEB-APR-STP-0059 test method) particle filtration efficiency (PFE) – and the testing parameters, such as face velocity. Variations in these quantities present challenges in comparing standards and studies and results in differences in terms of the quality of standards. Here, we examine a range of these parameters and systematically consider their effect on measured PFEs. We start by examining the aerosol physics underlying the associated measurements, providing a discussion of the different types of particle size (e.g., mobility and aerodynamic diameters) and the differences between number- and mass-weighted PFEs. We discuss the non-trivial relationship between mass- and number-weighted PFEs and show that the number-weighted PFE is typically more conservative (lower) for many of the conditions relevant to PFE standards. We also examine this relationship for a specific set of materials where the basis weight and charge state of the filter material were systematically varied. We then explore the role of face velocity, particle properties (size distribution, electric charge, density, and shape), measurement techniques, and environmental preconditioning. We combine systematic experiments with data mining of a database of over 900 samples. For the range of values relevant to filtration efficiency testing, most important parameters are found to be face velocity and particle charge. Our results provide guidance for future testing protocols and a basis for the comparison of respirators certified under various international methods, including FFP2, KN95, P2, Korea 1st Class, and DS2.

9ID.10

Binding Behavior of Spike Protein and Receptor Binding Domain of the SARS-CoV-2 Virus at Different Environmental Conditions. MEIYI ZHANG, Haoqi Wang, Emma Foster, Zivko Nikolov, Sandun Fernando, Maria King, *Texas A&M University*

A novel coronavirus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was identified as the cause of the COVID-19 pandemic that originated in China in December 2019. Although extensive research has been performed on SARS-CoV-2, the binding behavior of spike (S) protein and receptor binding domain (RBD) of SARS-CoV-2 at different environmental conditions have yet to be studied. The objective of this study is to investigate the effect of temperature, fatty acids, ions, and protein concentration on the binding behavior and rates of association and dissociation between the S protein and RBD of SARS-CoV-2 and the hydrophobic aminopropylsilane (APS) biosensors using biolayer interferometry (BLI) validated with molecular dynamics simulation. Our results suggest three conditions—high ionic concentration, presence of hydrophobic fatty acids, and low temperature—favor the attachment of S protein and RBD to hydrophobic surfaces. Increasing the temperature within an hour from 0 to 25 °C results in S protein detachment, suggesting that freezing can cause structural changes in the S protein, affecting its binding kinetics at higher temperature. At all the conditions, RBD exhibits lower dissociation capabilities than the full-length S trimer protein, indicating that the separated RBD formed stronger attachment to hydrophobic surfaces compared to when it was included in the S protein.

9ID.11

Mucin Transiently Mitigates the Loss of Coronavirus Infectivity in Artificial Saliva. ROBERT ALEXANDER, Jianghan Tian, Allen E. Haddrell, Henry Oswin, Daniel Hardy, Edward Neal, Mara Otero-Fernandez, Jamie Mann, Tristan Cogan, Adam Finn, Andrew Davidson, Darryl Hill, Jonathan P. Reid, *University of Bristol*

Evidence indicates viral pathogens such as SARS-CoV-2 can be rapidly spread though the transmission of aerosolized expiratory secretions in the form of droplets or particulates. Understanding the fundamental aerosol parameters that govern how such pathogens survive whilst airborne is essential to understanding and developing methods of restricting their dissemination. Pathogen viability measurements made using Controlled Electrodynamic Levitation and Extraction of Bioaerosol onto Substrate (CELEBS) in tandem with comparative kinetics electrodynamic balance (CK-EDB) measurements, allow for direct comparison between viral viability and evaporation kinetics of the aerosol as a function of time.

Although the main constituent is water (>95%), respiratory saliva is a mixture of mucus, cellular debris and immunological factors. The physiochemical properties of saliva are heterogenous over time and dependent on the age, diet and disease state of an individual. Using real saliva to experimentally model the infectivity of pathogens in the aerosol phase is challenging as a result of this variability. Consequently, model respiratory fluids such as artificial saliva or tissue culture media are used to replicate the evaporation dynamics of expired respiratory secretions in a controlled procedure.

Here, we report the survival of a coronavirus, the Mouse Hepatitis Virus, in model artificial respiratory fluids to determine the suitability of artificial salvia as a surrogate for clinical saliva samples. We see a comparable loss of infectivity of MHV in the aerosol phase in artificial saliva and growth media, indicating that the physicochemical properties and evaporation dynamics that drive the loss of viral infectivity are the same. Further, we will show that the inclusion of clinically relevant mucin concentrations to the samples result in a transient protection of the virus over only a timescale of 2 mins. We also will confirm that aerosol pH and phase change are significant factors determining virus infectivity.

9ID.12

Detection of Pathogen Sequences in Bioaerosols of Wastewater. DAVID ALBURTY, Namrita Dhillon, James Brayer, Hugh Olsen, Miten Jain, Norman Kado, *InnovaPrep LLC*

The way Americans think about public health has changed over the last century. Validation of the germ theory of disease, coupled with development of antibiotic drugs and vaccines have gradually displaced the social/behavioral strategies for public health that were prevalent in the 1800s. The global SARS-CoV-2 pandemic has reinforced the importance of environmental monitoring and social factors for public health by highlighting the critical importance of SARS-CoV-2 aerosol transmission and use of wastewater epidemiology for prevention of SARS-CoV-2 transmission. The environmental monitoring community continues to develop improved integrated tools for use in both aerosol pathogen detection and wastewater-based epidemiology. One such tool is presented here in which simultaneous wastewater and aerosol monitoring were conducted at an on-premise university wastewater treatment plant. Samples were analyzed using nanopore sequencing, and results presented here show the utility of sequencing for monitoring any pathogen (viral, bacterial, or fungal) in sewershed populations, and by extension, environmental aerosol monitoring near contaminated surface waters.

9ID.13

Assessing Indoor Air Quality in Educational Buildings Using a Low-Cost Sensor Network. JIANING BAO, Nigel Kaye, Ehsan Mousavi, Christopher Post, Vincent Blouin, Andrew Metcalf, *Clemson University*

The current COVID-19 crisis highlights the need for safer building environments regarding indoor air quality, especially for high-occupancy indoor environments including schools and colleges. Low-cost indoor air quality sensor technology provides the opportunities to measure indoor pollutant concentrations with high temporal and spatial resolution by deploying multiple sensors in indoor spaces horizontally and vertically. The objective of this study is to use a low-cost sensor network to evaluate indoor air quality by measuring the concentrations of particulate matter (PM), carbon dioxide (CO2), total volatile organic compounds (TVOC), temperature, and relative humidity (RH) at multiple locations in a classroom. We conducted experiments with point sources of PM and CO2 into the indoor space. By analyzing the decay of PM and CO2 concentrations with time, we evaluate the effectiveness of the ventilation and filtration system in the classroom. The low-cost sensor network also measures the spatial variability of pollutant concentrations, including horizontal spreading and vertical stratification, which shows the spatial evolution of pollution distribution from point sources. Finally, we evaluate the performance of various indoor air pollution mitigation techniques, including HEPA filters and low-cost, do-it-yourself filtered box fans.

9ID.14

Latitude and Weather Influence Incidence of Legionnaires' in the US. REESE BARRETT, Dewansh Rastogi, Akua Asa-Awuku, *University of Maryland, College Park*

Legionnaires' disease, first detected in 1977, is a pneumonia caused by Legionella bacteria, usually L. pneumophila. Person-to-person transmission is not observed, but outbreaks can occur and exposure to clusters of people is common. Usually, infection is caused by the inhalation of aerosols that contain the bacteria. Since the first known outbreak in 1976, incidence of Legionnaires' disease has been increasing annually. Some environmental conditions that can lead to outbreaks have been studied on regional scales and documented in the literature. In this work, we investigate the correlation of weather conditions to Legionnaires' disease in the US from extensive meteorological data and public health records (totaling 62,052 data points). Weather data on temperature, precipitation, and relative humidity from each weather station available in the National Climatic Data Center database was compared with all available historical data from the Centers for Disease Control and Prevention on the incidence of Legionnaires' disease from the years of 1996 to 2019. It was determined that a normally-distributed correlation between the change in average temperature and incidence exists, with less temperature variation present during high levels of incidence. Moreover, a quasi-linear correlation (R2 = 0.7148) between latitude and incidence was discovered, with lower latitude states in the United States consistently presenting higher levels of incidence. Results of this work indicate that warm locations with minimal temperature variability are likely to experience the most Legionnaires' cases. As global weather patterns continue to change over time, disease incidence will likely change as well, but further analysis is needed to clarify this relationship.

9ID.15

Assessment of Best-Selling Respirators and Masks: Do We Have Acceptable Respiratory Protection for the Next Pandemic? Omar Chaaban, Jo Anne Balanay, SINAN SOUSAN, *Department of Public Health, East Carolina University*

COVID-19 pandemic caused a high demand for respiratory protection, caused a scarcity of approved respirators and the production of alternative respiratory protection. To raise public awareness through the scientific community, bestselling respirators and masks in the United States leading online retailer, Amazon.com, were evaluated. Ten respirators and masks, 5 Face Protective Equipment (FPE) and 5 Cloth Face Masks (CFMs), were evaluated compared to the N95 standard. Two groups were established with the intention of comparing all masks together. The fractional efficiency and pressure drop were measured and compared to the National Institute for Occupational Safety and Health (NIOSH) standards. In addition, grading factors for protection, comfort, and affordability were developed that can be used by the scientific community to readily disseminate to consumers for the selection of the appropriate respiratory protection. Two FPE provided acceptable efficiency (>95%) similar to the N95, while the remaining products were below or extremely below NIOSH standards. All products provided pressure drops within NIOSH standards (≤35 mmH20) ranging from 2.3-10.3 mmH$_2$0. The grading factors show that the CFMs have minimal protection, and the N95 has average comfort and affordability compared to all the products. The N95 remains the best respiratory protection, and in the event of the next airborne pandemic, FPEs could serve as adequate alternative protection against the viral spread.

9ID.16

Simulation of Exhaled Droplets and Their Evolution in Common Indoor Environments. SANIKA NISHANDAR, Yucheng He, Marko Princevac, Rufus Edwards, *University of California, Riverside*

COVID-19 pandemic has highlighted the importance of understanding virus transmission in community settings. Computational Fluid Dynamics (CFD) enables systematic examination of the trajectories and roles the exhaled droplets play in the spread of SARS-CoV-2 in indoor environments. Experimentally measured droplet size distributions exhaled during speaking and coughing were used to simulate droplet dispersion, evaporation, and deposition in a supermarket checkout area and car where close proximity to individuals is common. The exhaled droplets only partially evaporate and stay suspended as terminal nuclei. The trajectories of the residual nuclei of size 0.3µm, based on measured peak concentrations for SARS-CoV-2 RNA in aerosols, were also simulated. Using standards for ventilation and comfort in the supermarket and car, simulations demonstrate that exhaled droplets with diameters smaller than 20µm evaporate and leave residual droplet nuclei which remain aerosolized in the air. Subsequently ~30% of these aerosolized nuclei deposit in the supermarket as well as the car, with remainder of the nuclei eventually being vented. The maximum surface deposition was 2 and 819 nuclei m^{-2} for speaking and 18 and 1387 nuclei m^{-2} coughing in the supermarket and car respectively. But the distribution of viral RNA is not linear across droplet sizes and larger exhaled droplets that deposit on surfaces have low viral content. Average surface deposition of viral RNA was 44 and 237 copies m^{-2} for speaking and 2988 and 12539 copies m^{-2} for coughing in the supermarket and car respectively. The initial airborne concentration of viral RNA was 7×10^6 copies per ml. Integrating the droplet statistics with viral load distributions, this study helps explain the apparent importance of inhalation exposures compared to surface contact observed in the pandemic.

9ID.17

Sampling and Detection of Sars-Cov-2 Aerosol in Well and Poorly Ventilated Places and Its Exposure Risks: A Review of Field Sampling Studies. YUETONG ZHANG, Sripriya Nannu Shankar, William Vass, John Lednicky, Z. Hugh Fan, Duzgun Agdas, Chang-Yu Wu, *University of Florida*

As SARS-CoV-2 continuously sweeps throughout the globe, the White House Office of Science and Technology Policy (OSTP) and other federal agencies have collaborated together to introduce the Clean Air in Buildings Challenge, which emphasizes better ventilation, filtration, and air disinfection. Data from 30 SARS-CoV-2 field sampling studies from the literature, including isolation homes (9) and hospitals (25), were compiled to assess whether better ventilation leads to lower exposure risk. Air changes per hour (ACH) was used as a surrogate for ventilation. The concentration of virus RNA in air (quantified by RT-PCR) and the percentage of air samples that tested positive for SARS-CoV-2 (positivity rate) were used to inform exposure risk. The ACH values were averaged across hospitals and isolation homes, respectively, and the ACH for each hospital was averaged over all room types. The mean ACH was higher in hospitals (10.6) compared to isolation homes (1.4). The mean positivity rate was calculated across hospitals and homes, respectively. The positivity rate in hospitals (24.1%) was moderately lower compared to that in isolation homes (38.0%). The virus RNA concentration was averaged across all air samples at hospitals and homes, respectively. The mean concentration of SARS-CoV-2 RNA in hospital settings (102 copies/L) was significantly lower compared to that in isolation homes ($1.9*10^7$ copies/L). While a larger sample size and more consistent sampling protocols (e.g., placement of the sampler, type of sampler, primer used, and sampling duration) will reduce uncertainty, our analysis illustrates that the exposure risk of SARS-CoV-2 is higher in isolation homes compared to hospital rooms, and a higher ventilation rate can reduce the exposure risk.

9ID.18

Size-Fractionated Bioaerosol Collection in Liquid Medium with a Novel BioCascade Impactor. YUQIAO CHEN, Jiayi Chen, Sripriya Nannu Shankar, Stavros Amanatidis, Arantzazu Eiguren-Fernandez, John Lednicky, Chang-Yu Wu, *University of Florida*

Studies on the transmission mode of bioaerosols are hampered due to limitations of existing methods on size-fractionated collection and inability to maintain their viability. BioCascade, a novel size-fractionating sampler, collects particles based on their aerodynamic diameters (>10 µm, 4-10 µm and 1.5-4 µm for stages 1-3, respectively) onto Petri dishes containing liquid medium and could be paired with a gelatin filter (GF) or a condensation-based growth tube collector (CGTC) to collect particles <1.5 µm. We tested the performance of the BioCascade using aerosolized *Saccharomyces kudriavzevii* (5-6 µm). The aerosols were diluted with compressed air at a ratio of 1:3.5 and then collected by (1) BioCascade+CGTC; (2) BioCascade+GF; (3) CGTC and (4) GF. The colony forming units (CFU)/mL were $1.16\times10^4\pm3.90\times10^3$ and $1.31\times10^4\pm5.92\times10^3$ in the samples collected by stages 2 and 3 of BioCascade, respectively, the size range of which corresponds to the nominal size of *S. kudriavzevii*. The CFU/mL recorded in stage 1 ($1.80\times10^3\pm5.83\times10^2$) was ~6-7 times lower than that from stage 2 and 3. Experiments conducted with 2 mL of yeast suspension in PBS on a given stage and only PBS in successive stages demonstrated that there was no re-aerosolization within the stages of BioCascade. The ability of BioCascade to preserve the viability of bioaerosols collected was evaluated by exposing 2 mL of yeast suspension in PBS in the collector, to particle-free air. Gelatin filter, when paired with BioCascade as stage 4, did not collect viable *S. kudriavzevii*, while CGTC as stage 4 of BioCascade collected ~133 CFU/mL. In summary, the BioCascade can effectively collect viable *S. kudriavzevii* aerosols according to their particle size, maintain their viability (>80%), and have no re-aerosolization of collected *S. kudriavzevii*.

9ID.19

Measurement of Airborne Virus (Influenza A) Concentration before and after Resuspension Activity. MAHENDER SINGH RAWAT, Andrea Ferro, *Clarkson University*

Many respiratory viruses, including influenza and COVID-19, are transmitted via the emission and inhalation of infectious respiratory aerosols in indoor environments. Resuspended particles from the surfaces can be a major source of airborne microbiological contaminants in indoor environments; however, it is unknown whether resuspended viruses contribute substantially to disease transmission. In this study, we investigated the resuspension of influenza A virus x31 H3N2 strain (7 ml of phosphate buffered saline with 109 virus stock), which was generated through a nebulizer into a sealed biosafety level 2 laboratory. After allowing the particles to settle on the floor and other surfaces for several hours, an investigator entered the room to resuspend the particles via 15 minutes of human walking activity. Air samples were collected during the emission and resuspension periods using the impingers, and surface samples were collected using swabs and petri dishes. An array of optical particle counters (Purple Air) and an aerodynamic particle sizer (TSI model 3321) were used to continuously measure the particle concentration in the room during the experiments. We used RT-PCR to measure the viral load collected in the impingers and surface samples. The viral load following the resuspension events were approximately two orders of magnitude lower than that following direct emission via the nebulizer. Thus, depending on the infectious dose and viability of a particular virus, resuspension of settled respiratory viruses could lead to transmission, but the risk appears to be much lower than for direct emission. Due to a higher intake fraction (fraction of emitted particles that are inhaled), resuspension of virus particles from clothing could be more important than resuspension from flooring during human activity.

Key words: resuspension, Influenza, virus, transmission, indoor aerosols

9IM.1

Assessing Air-Quality of Delware by Integarting Satellite Observations with Field Measurements. Al Alexis, Yue An, Zayna Juracka, Zakaria Juracka, Ryan Bischof, MOHAMMAD KHAN, *Delaware State University*

Local air-quality awareness is critically needed in the state of Delaware (DE). Many southern and northern regions in the state are very distinct, with diverse outdoor and indoor air pollution sources and greenhouse gas emissions. Air quality is impacted by many sources, including agriculture (primarily in Kent County), poultry (Sussex County) in Southern DE, and industry (Power plants and chemical refineries located in New Castle County) in Northern DE. A network of low-cost precision sensors is required to comprehensively profile emissions in a wide geographical area. This paper shows the design and development of integrated optical and satellite observations that enable a high spatiotemporal resolution map of emissions across the state- constraining biotic and abiotic sources. This project shows the field operation of laser-based methane, carbon monoxide, nitrous oxide, and Sulphur dioxide. The sensors are based on probing rotational, vibrational molecular transitions of a suite of chemical species using near-infrared and midinfrared distributed feedback lasers and modulation spectroscopy. The field deployment of the sensors was conducted in collaboration with Delaware Natural Resources and Environmental Commission (DNREC). The air quality between southern, central, and northern Delaware is compared with sensor deployment at multiple DNREC air monitoring sites across Delaware.

9IM.2

A Multi-angle Optical Particle Sizer to Improve In Situ PM2.5 Characterisation. SETH ARTHUR-HASTIE, Katherine Manfred, *The University of York*

Anthropogenic aerosols (PM2.5) have significant effects on both atmospheric conditions and respiratory health, dependent on physical properties such as size and morphology. On-line/in situ characterisation techniques rely on an assumption of spherical particles. Off-line techniques such as electron microscopy can characterise non-spherical morphology but cannot effectively characterise properties that vary over a short timescale.

The Multi-angle Particle Sizer (MPS) is a new instrument designed to perform in situ PM2.5 analysis without the need to assume particle morphology or refractive index. The MPS follows many of the same design principles as widely used optical particle sizers (OPS) that measure aerosol size distributions using light scattered by individual particles. Like traditional OPSs, the MPS provides a simple, compact, sensitive, and inexpensive characterisation technique.

The MPS differs from conventional OPS by using three photomultiplier tubes (PMTs) to capture different angular regions of light scattering. A 445 nm laser beam scatters off a particle jet in a small spherical chamber. Portions of scattering are directed by three bi-concave lenses (48-degree arcs centred at 58.5 , 90.0 and 121.5 degrees) to the PMTs.

Absolute scattering intensities provide information on particle size, while comparisons of the amount of light scattered over different angles allows for distinction between spherical and non-spherical particles. Recent instruments have utilised this principle to characterise non-spherical particles, but the MPS' novel modular, 3D-printed design provides the flexibility to be adapted for different applications with minimal re-design.

Based on MPS geometry, lookup tables have been produced to allow identification of typical particle morphologies using common modelling theories, including Mie scattering (spheres), T-matrix (spheroidal particles) and Rayleigh-Debye-Gans (RDG) for fractal particles. These tables are composed of absolute scattering and the relative scattering captured from the three angle ranges.

Progress in the measurement and classification of non-spherical particles in the laboratory will be presented.

9IM.3

Response of Two Total Carbon Analyzers to Various Aerosols.

JOEL CORBIN, Daniel Clavel, Timothy Sipkens, Gregory Smallwood, *National Research Council Canada*

Particulate matter (PM) in the atmosphere and in combustion emissions is often dominated in mass by carbon. The total carbon mass (TC) can be converted to total PM mass if the mass fraction of heteroatoms such as O and H is known. TC can be viewed as the sum of organic carbon (OC, a proxy for volatile organic compounds) and elemental carbon (EC, a proxy for black carbon) as defined by thermal-optical analysis (TOA) or similar techniques. No matter what technique is used, the division of TC into specific species tends to result in operationally defined categories, since carbonaceous materials often have a continuum of properties. The overlap between properties can be severe (such as for heavy fuel oil and biomass burning) or negligible (such as for mixtures of lubrication oil or secondary organic aerosols with soot). Additionally, categorization tends to come at the sacrifice of sensitivity in TOA and other techniques.

To address some of the above concerns and the need for simpler TC measurements, two instruments have recently been introduced: the Magee TCA08 (Aerosol doo, Slovenia) and the fast thermal carbon totalizer (FATCAT; University of Northwestern Switzerland FHNW, Switzerland). Both of these instruments collect PM on internal filters; heat the samples to ~1000 K over ~1 minute in air; and measure any evolved CO2 using NDIR detectors. However, there are some significant differences. The TCA08 uniquely uses quartz fibre filters similar to those used in TOA; heats samples in an oven containing metal coils; and is already in commercial production. The FATCAT uniquely uses a metal filter which is heated directly by induction; and includes a catalyst to convert all hydrocarbon evolved gases to CO2.

In this work, we systematically explored the ability of the TCA08 and FATCAT to serve as a TC measurement devices for potential regulatory applications. Due to the lack of a CO2 conversion catalyst, the TCA08 response factor to organics (“OC”: sucrose, dioctyl sebacate, and hexadecane) was an order of magnitude different to that for soot (“EC”). Consequently, the calibration factor is also a function of the EC/TC ratio. The corresponding FATCAT response factor showed a negligible dependence on the composition of the PM. Repeatability for samples of similar composition was excellent for both instruments. We have also explored the potential use of the carbon analyzers’ thermograms for distinguishing various carbons and will discuss the results.

9IM.4

A Continuous Flow Microfluidic Based Instrument for Measuring Ice Nucleating Particles.

ETHAN EMERSON, Kate Patterson, Matt Freer, Ben Swanson, Andrew Metcalf, Russell Perkins, Jessie Creamean, Paul DeMott, Gavin McMeeking, *Handix Scientific*

Ice nucleating particles (INP) affect climate and precipitation by impacting the formation of ice in clouds. Existing online or continuous measurements require large and power intensive instruments, which limits the number and location of high temporal resolution and long duration INP observations. We present a new approach for measuring INP in a liquid sample continuously using microfluidics. This approach allows for online analysis using a particle-into-liquid sampler (e.g., Liquid Spot Sampler) or offline sample analysis of filter samples extracted into liquid. The Continuously Operating System for Microfluidic Ice Counting (COSMIC) is capable of measuring INP concentrations as a function of temperature, ranging from approximately 0 to -30 C with minimal user intervention. The measurement system fits in a standard 19-inch rack and occupies 9 inches of vertical space. The current prototype uses a standard laboratory chiller operating on standard AC power, making the system more flexible than current online measurement techniques. We present instrument characterization, including measurements of freezing spectra of previously characterized INP, including minerals, dusts, and biological particles, as well as field samples. Results are compared to measurements from the Colorado State University Ice Spectrometer. We will also discuss the ongoing work to couple COSMIC to a particle-into-liquid sampling system that provides continuous measurements of INP in air.

9IM.5

A Low-Cost Particle Sensor Grid for Aerosol Wind Tunnel Studies. BOBBY GUILFOIL, Suresh Dhaniyala, *Clarkson University*

Aerosol wind-tunnel studies are critical for evaluation of the performance of aerosol inlets and instruments. Such evaluation studies require the establishment of uniform aerosol concentration in the tunnel cross-section, to ensure that the concentration of the test instrument is independent of its exact location in the tunnel. Obtaining uniform concentration in a large wind-tunnel, such as Clarkson's aerosol wind-tunnel that has a 4 foot by 3 foot cross-section, is non-trivial. To effectively develop new strategies to obtain uniform seeding in the tunnel, new evaluation techniques that can map the real-time spatio-temporal variation in the tunnel are required. In this study, we evaluate the use of a low-cost sensor network for real-time wind-tunnel aerosol mapping. Using LoRa mesh-networked sensors distributed in a grid, we wirelessly mapped the aerosol uniformity in the tunnel for a range of aerosol injection approaches. We will present the design of the sensor grid and the final wind-tunnel injection approach that resulted in a uniform aerosol distribution in the tunnel.

9IM.6

Performance Evaluation of an Aerosol Collection Device for Bioaerosol Characterization. HUNTER HARDY, Kavindra Kumaragama, Suresh Dhaniyala, *Clarkson University*

The growth in prevalence and diversity of low cost sensors has driven new measurement approaches and application areas. Such devices are predominantly being deployed to monitor ambient conditions. The emergence of these new sensors has necessitated new methodologies to quantify their performance. In our study, we evaluated a commercial low-cost electrostatic collector from TelosAir, for airborne biological microorganisms integrated with low-cost real-time aerosol sensors. We developed a well characterized experimental setup for this performance evaluation and established a robust approach to analyze the performance of the bio-collector unit. We established the size-dependent collection efficiency of the bio-collector and reported the performance of the unit in terms of its effective sample flow rate. The low-cost bio-collector is seen to have a near size-independent collection performance, with an effective sample flow rate of ~ 7-10 LPM, making it ideal for routine indoor sampling. We will present the collector design, the evaluation approach, and the experimental results from our testing.

9IM.7

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

Ambient aerosols may contain hundreds or thousands of unique organic compounds, and even minor components which may provide valuable insight into particle sources and formation chemistry. However, due to the complexity of this data and the highly dynamic nature of aerosol composition, conventional analysis methods tend to be highly time consuming and also result in a substantial fraction of data never being analyzed or interpreted. We have recently developed new methods to more comprehensively identify the full suite of analytes in a complex dataset by coupling Positive Matrix Factorization (PMF) with a peak-filtering decision tree. In this presentation, we apply these methods to existing datasets collected by the Semi-Volatile Thermal Desorption Aerosol Gas chromatograph (SV-TAG) in Manacapuru, Brazil during the wet season of 2014 to identify new analytes and interpret their variability and transformations in the atmosphere. The analysis results find roughly 1000 potential analytes of interest. We apply two matrix size reduction techniques, PMF and hierarchical cluster analysis (HCA) to yield new insights into the covariance and sources of previously overlooked analytes. In particular, we seek to understand the removal of these compounds through gas scavenging by precipitation. Comparison of analyte groups before, during, and after a precipitation event are used to qualitatively and quantitatively understand the impacts of this process on atmospheric composition.

9IM.8

A Bipolar Chemical Ionization Mass Spectrometer for the Detection of Aerosol Precursors. Markus Leiminger, Tobias Reinecke, MARKUS MUELLER, Tobias Fügenschuh, Zsolt Dányi, Alfons Jordan, *Ionicon Analytik GmbH, Austria*

Volatile organic and inorganic compounds (VOC, VIC) react in the gas phase with ozone, nitrate or hydroxyl radicals, creating reaction products of major relevance for atmospheric and indoor chemistry with implications for climate and health. An established technique to study these compounds is chemical ionization mass spectrometry (CIMS). However, since there is no universal reagent ion covering all compounds of interest, combining ionization techniques is necessary.

Here we present the first dual-polarity PTR3 CI-TOF (IONICON Analytik, Austria), considerably extending the number of possible reagent ions and thus the application range. This instrument reaches sensitivities of 30.000 cps/ppbV at a typical mass resolution of >10.000 m/dm. The tripole reaction chamber is operated at around 75 mbar and allows for precise control of the reaction conditions by adjusting the reduced field strength (E/N) from field-free up to 120 Td (1 Td = 10−17 Vcm−2). Bipolar electronics enable electrical switching between positive and negative polarity, extending the range of positive reagent ions (i.e. H_3O^+, NO^+, NH_4^+) to negative ions like I^- and CH_3COO^-.

To characterize this dual-polarity PTR3 CI-TOF, we have conducted a series of oxidation experiments with relevant and well-studied VOC precursors. In this work, we compare the chemical response to secondary organic aerosol (SOA) produced from the oxidation of limonene with ozone as characterized by different reagent ions. The bipolar electronics offer switching speeds between ions of the same polarity of down to 1 s and between polarities within 10 s. This allows quasi-simultaneous tracking of experiments with all three reagent ions. Preliminary results demonstrate the advantages of I^- and CH_3COO^- for detecting highly oxygenated molecules (HOMs) compared to the benefit of detecting precursor VOCs in positive mode with H_3O^+.

9IM.9

Advancements to the Handix Scientific Continuous Flow Diffusion Chamber. EZRA LEVIN, Gavin McMeeking, Russell Perkins, Matt Freer, Anna Hodshire, Anna Gannet Hallar, Tom Ramin, *Handix Scientific*

Ice nucleating particles (INP) are necessary for primary ice formation in clouds and play a crucial role in precipitation formation and alteration of cloud radiative properties. Despite their importance, however, there are limited measurements of INPs, largely due to the historical limitations of INP instrumentation, which until recently required an on-site operator or labor-intensive post processing of collected samples. New advancements in INP measurement technology have greatly improved our ability to make more frequent and longer-term measurements. One such instrument is the Continuous Flow Diffusion Chamber – Ice Activation Spectrometer (CFDC-IAS, Handix Scientific) which is based on the well-established design of the Colorado State University CFDC but modified to allow for near-continuous and autonomous operation. In this presentation we will discuss changes made to the CFDC to improve usability and reliability and will present data from a four-month deployment of the instrument at Storm Peak Laboratory in the mountains of Colorado. We will also present recent advancements to the instrument to allow for mobile measurements from both a ground based mobile laboratory and a research aircraft.

9IM.10

An Intercomparison of Instruments Measuring Carbonaceous Aerosol Light Absorption. AUGUST LI, Rajan K. Chakrabarty, *Washington University in St. Louis*

In this research, laboratory measurements of light absorption of fresh-emitted carbonaceous aerosol generated from biomass combustion, along with the aerosol mass concentration, were collected. The goal of this research is to compare the absorption measurements from three different instruments: a particle soot absorption photometer (PSAP) and a tricolor absorption photometer (TAP), and a photoacoustic spectrophotometer (PAS). PSAP and TAP are filter-based instruments that measure absorption at red, green, and blue regions on the visible spectra (the specific wavelengths for the two instruments are slightly different), whereas the PAS measure absorption at 405, 721, and 1047 nm wavelengths. Therefore, the absorption at different wavelengths needs to be adjusted for comparison. Preliminary results showed that absorption measurements from the PAS are mostly lower than those from the PSAP, with comparison slope ranges from 0.42 to 1.62. The single scattering albedos for the fresh biomass burning aerosol are 0.91–0.94 405 nm wavelength, 0.91–0.95 at 532 nm, and 0.90–0.95 at 660 nm. Future steps for this research include comparison of absorption measurements between the PAS and TAP, and between TAP and PSAP. The effects of mass concentration (collected by a scanning mobility particle sizer) on aerosol absorption measurements will also be taken into consideration by deriving the mass absorption coefficients (MAC) for the instruments at all wavelengths.

9IM.11

Light Obscuration to Monitor Aerosol Delivery from Dry Powder Inhalers. SARA MALONEY, Lynn Davis, Anthony Hickey, *RTI International*

Metrics of aerosol performance from dry powder inhalers (DPIs) are largely derived from in vitro cascade impaction and delivered dose uniformity analyses, giving rise to the aerodynamic particle size distribution (APSD) and emitted dose, respectively. However, from these metrics alone, a critical measurement is missing related to predicting in vivo performance. As aerosol release from a DPI is initiated by the inspiratory flow of the patient, the aerosol delivery rate (ADR) dictates where on the inspiratory flow the aerosol is delivered, and consequently, the regional lung deposition. The incorporation of a light obscuration window prior to aerosol entry to the cascade impactor allows for ADR to be monitored. A system was devised in which an LED light source (wavelength = 940 nm, intensity = 25 mW/sr, Kingbright) was directed to a near-IR mini-spectrometer (STS-NIR; Ocean Insight) across a sampling tube. The detector was connected to and operated by OceanView 2.0 software (Ocean Insight). Model powders of albuterol prepared through jet milling/lactose blending or spray drying were delivered from a #3 HPMC capsule using an RS-01 inhaler (Plastiape, Italy), and light obscuration data was collected to accompany cascade impaction data. Obscuration by the delivered powders while traveling through the sampling tube resulted in a decrease in absorbance measured by the mini-spectrometer. The absorbance profile gave rise to ADR metrics, including onset time, transit time, amplitude of response, and area under the response curve. Through the combination of the sampling apparatus and cascade impactor, both the ADR and APSD were simultaneously determined, and the influence of formulation characteristics on performance was established. Light obscuration as a complementary method for characterizing dry powder inhaler performance adds an additional in vitro metric that is also relevant for predicting in vivo performance.

9IM.12

Development of a Machine-Learning Model for Prediction of the Aerosol Scattering Ångström Exponent (SÅE) from Purple Air Sensor Data. ZACHARY MCQUEEN, Ryan Poland, Geoffrey Smith, *University of Georgia*

Purple Air (PA) sensors have provided affordable access to local concentrations of particulate matter at various size ranges. Each PA sensor utilizes a pair of laser particle counters to measure the particle concentrations at six different size bins based on the measured particle light scattering [1]. From these size-resolved mass concentrations, we are able to train machine-learning models to predict the scattering Ångström exponents for ambient aerosols in our area (Athens, GA). We use high-sensitivity, multi-wavelength photoacoustic spectroscopy and cavity ring-down spectroscopy to train and compare our model predictions to real measurements of the SÅE [2]. Several types of models are tested, including Support Vector Machines, Gaussian Process regression, and ensemble methods such as Boosted Tree Regression. We plan to make our models available for public users of Purple Air sensor data so they can estimate the SÅE in their local area.

[1] https://www2.purpleair.com/pages/technology
[2] D. Al Fischer & Geoffrey D. Smith (2018) A portable, four-wavelength, single-cell photoacoustic spectrometer for ambient aerosol absorption, Aerosol Science and Technology, 52:4, 393-406

9IM.14

Quantitative Chemical Assay of Nanogram-Level PM Using Aerosol Mass Spectrometry Coupled with an Isotopically Labeled Internal Standard: Application to Samples Collected from Uncrewed Arial Systems. CHRISTOPHER NIEDEK, Fan Mei, Maria Zawadowicz, Zihua Zhu, Beat Schmid, Qi Zhang, *University of California, Davis*

Aerosol generation techniques have expanded the utility of aerosol mass spectrometry (AMS) for offline chemical analysis of airborne particles and droplets. However, standard aerosolization techniques require relatively large liquid volumes (e.g. several milliliters) and high sample masses that limit their utility. Here we report the development and characterization of a micronebulization-AMS technique that requires only microliter volumes of sample and can provide quantification of nanogram levels of organic and inorganic substances via the usage of an isotopically labeled internal standard ($^{34}SO_4^{2-}$). Using standard solutions, the detection limits for this technique were determined as 2.6 and 0.086 ng for organics and sulfate, respectively. This technique was applied successfully to analyzing filter and impactor samples collected using miniature particulate matter (PM) samplers deployable on uncrewed aerial systems (UASs). Chemical composition of ambient PM samples collected from a UAS field campaign conducted at the DOE Southern Great Plains (SGP) observatory was characterized and the results were compared to real-time aerosol chemistry measurements made by an Aerosol Chemical Speciation Monitor (ACSM). This study demonstrated that the micronebulization system in combination with offline AMS analysis provides a robust platform for quantitative chemical analysis of PM samples with solute concentrations in the µg/L range and sample volumes in the sub-mL range.

9IM.15

Towards Minimizing Turbulence in Aircraft Inlets.
NAGARAJAN RADHAKRISHNAN, Suresh Dhaniyala, *Clarkson university*

Characterization of properties of stratospheric aerosol particles requires efficient and repeatable aerosol sampling from aircraft platforms. When flow is sampled isokinetically, the flow enters the inlet at high speed and is at a high Reynolds number in the sample tube. Even with the subsequent slowing of the flow, the Reynolds numbers in the sample tube are often high and the flow is turbulent. Flow turbulence can result in significant transport losses for particles, resulting in sampling biases that are difficult to correct theoretically. In this study, we evaluate the low turbulence inlet (LTI) design of Prof. Wilson’s group at Denver University. The LTI, designed for effectively sampling super-micron particles from low-speed aircraft, required boundary layer suction through a porous tube to minimize turbulence in the primary flow. The large size of the inlet, coupled with the need for a large suction pump makes it difficult for the LTI to be deployed with higher altitude aircraft. To improve the LTI design, we evaluated different approaches for boundary layer suction and their impact, flow, and particle transport through the inlet. We will present the different approaches and flow field results, their implications for sampling, and also describe our first design for a compact low-turbulence inlet for use with high-speed aircraft.

9IM.16

A Flexible Tool for Retrieving and Working with PurpleAir Sensor Data.

GEOFFREY SMITH, *University of Georgia*

There are over 20,000 low-cost PurpleAir sensors deployed around the world measuring particulate matter concentration. Most of these sensors report their data through a publicly-available web interface [1], which serves as a valuable resource for researchers and hobbyists alike. However, retrieving historical data for specific sensors is cumbersome as four separate CSV files must be downloaded and combined for each sensor. And, while PurpleAir does provide an API (Application Programming Interface) that can be called from various programming languages, it can only retrieve the most recent data. Alternatively, historical data from individual sensors can be retrieved from the Thingspeak service, but doing so requires several steps and is limited to retrieving at most 11 days of data at a time. What is more, there are no tools for post-processing the data after they have been retrieved.

Here, we describe a set of MATLAB tools that we have developed to make it easy for users to find the PurpleAir sensors near any location and to retrieve historical data for one or more sensors. The tools also provide a convenient way to process data from several sensors with a consistent “pipeline” that includes options to average, “clean," visualize and correct the data, including the “US EPA” [2] and “LRAPA” [3] corrections. These tools have also been designed in a way that makes it easy for the user to extend or modify them to add custom data processing functionality.

[1] map.purpleair.com (Accessed April 28, 2022)
[2] Barkjohn, K. K., Gantt, B. & Clements, A. L. Development and application of a United States-wide correction for PM2.5 data collected with the PurpleAir sensor. Atmos Meas Tech 14, 4617–4637 (2021).
[3] https://www.lrapa.org/DocumentCenter/View/4147/PurpleAir-Correction-Summary (Accessed April 28, 2022).

9IM.17

Leveraging Machine Vision in a Liquid Level Controller for Long-Term Aerosol Capture with a Water Condensation Growth Tube Sampler.

BRADEN STUMP, Panupoan Xiong, Dominick Heskett, Greg Brandes, Patricia Keady, Arantzazu Eiguren-Fernandez, Nathan Kreisberg, *Aerosol Devices Inc.*

Aerosol Devices Inc. has developed multiple water condensation growth tube samplers that collect and concentrate aerosol particles into a small volume liquid vial. These samplers have opened many opportunities for bioaerosol capture due to their gentle, high efficiency collection over a wide size range (<10 to 10,000 nm) and the ability to maintain viability. However, with a low concentration of bioparticles in the environment, or the desire to sample over a fixed period (e.g., an 8-hour shift), long sample times are often desired. With longer sample times, the volume of liquid in the sample vial can vary due to (1) ambient temperature fluctuations causing liquid vial temperature to rise above or below the dew point of the aerosol exiting the growth tube causing water vapor to condense or evaporate from the sample; and (2) varying aerosol concentrations (including non-biological particles) that add water to the sample from the collection of condensed particle-droplets. A solution to this sampling challenge is to control the dew point from the condensation growth tube such that the water in the sample vial is condensing or evaporating to maintain a constant volume of liquid over a long sample period. Measuring the liquid level requires a non-invasive solution that cannot contaminate the sample. The Aerosol Devices Liquid Level Controller was developed in response to this user need. In this presentation we discuss the application requirements, design, and performance of this controller in detail. Liquid level is monitored with machine vision paired with control of the condensation growth tube’s moderator and sampler temperatures to maintain a constant liquid level in a non-invasive fashion. We report the efficacy of the device in controlling the liquid volume in a variety of environmental and aerosol conditions, using both the Biospot-GEM™ bioaerosol sampler and the Spot Sampler™ aerosol collector.

9IM.18

Laboratory Determination of Gravimetric Correction Factors for Real-time Area Measurements of Electronic Cigarette Aerosols. SINAN SOUSAN, Jack Pender, Dillon Streuber, Meaghan Haley, Will Shingleton, Eric Soule, *East Carolina University*

Research on secondhand electronic cigarette (ECIG) aerosol exposure using aerosol monitors has demonstrated that ECIG use can generate high concentrations of particulate matter (PM) and impact indoor air quality. However, quantifying indoor air PM concentrations using real-time optical monitors with on-site calibration specifically for different PM exposures has not been established. Therefore, the ECIG aerosol filter correction factors were calculated for different PM sizes (PM_1, $PM_{2.5}$, and PM_{10}) and different optical monitors, the MiniWRAS, pDR, and SidePak, by generating ECIG aerosols from five ECIGs. The aerosol size distribution by mass was measured for the five ECIGs during PM generation. Compared to the discrete filter measurements, the MiniWRAS performed the best when the concentrations were low, followed by the pDR and SidePak. The average PM concentrations and correction factor ranges for the different ECIGs were 323-1,775 $\mu g/m^3$ and 0.64-6.01 for the MiniWRAS, 1,388-13,365 $\mu g/m^3$ and 0.41-0.80 for the pDR, and 4,632-55,339 $\mu g/m^3$ and 0.13-0.20 for the SidePak, respectively. The mass median diameter ranged from 0.41 and 0.62 µm, and most particles generated from the ECIGs were smaller than 1 µm. This study demonstrates that aerosol size distribution varies between ECIGs. Likewise, the correction factors developed for the real-time aerosol monitors are specific to the ECIG used. Thus, these data can help improve ECIG aerosol exposure measurement accuracy.

9IM.19

An Inter-laboratory and Inter-instrumental Comparison of Elemental Loadings on PM2.5 Samples from the Chemical Speciation Network (CSN). COLLEEN MARCIEL ROSALES, Frank Weber, Tracy Dombek, Nicholas Spada, Nicole Hyslop, *University of California, Davis*

To fully understand the health effects of particulate matter (PM), accurate instrumental techniques that describe each component are paramount; however, in the past, studies that compared elemental analysis for PM have identified that there is no “one-size-fits-all” technique that could detect all desired elements, but rather a combination of techniques provided a determination of the elements in PM. At present, the two most commonly used techniques for elemental analyses are energy-dispersive X-ray fluorescence spectroscopy (ED-XRF) and inductively coupled plasma mass spectrometry (ICP-MS). In this study, we aimed to determine which elements are better measured via ED-XRF and/or ICP-MS. We analyzed samples collected from various locations across the United States by the US Environmental Protection Agency (EPA) Chemical Speciation Network (CSN) sampling network, a long-term national monitoring program created in 2000 to support the implementation of the 1997 PM2.5 National Ambient Air Quality Standards (NAAQS). Elemental analysis was done three times on each filter: first, ED-XRF at UC Davis; second, ED-XRF at RTI International, and lastly, ICP-MS at RTI International. We find that some elements, like K, Sr, Zn, Cu, Pb, Ba, and Mg have very good inter-instrument agreement between ED-XRF and ICPMS, while some lighter elements (Na, Mg, and Al) are better measured using ED-XRF. On the other hand, majority of the metallic elements that are present in lower concentrations in PM such as Sb, Pb, V, As, Ag, Fe, Cd, Rb, Ti, Sr, Ce, Zn, Zr, and Cu are better measured with ICP-MS. Lastly, we find that while ICP-MS is better for lower detection limits, accurate determination of soil-related elements such as Ca, Mn, and Ti is highly dependent on the digestion method employed. A combination of well-developed ED-XRF and ICP-MS techniques is necessary to properly quantify the elemental composition of PM collected from urban areas.

9IM.20

An Approach for Characterizing the Transmission Efficiency of Charged Aerosols through Static Dissipative Tubes Subject to Favorable and Adverse Axial Electric Fields.

FARNAZ KHOSRAVI, Francesco Carbone, *University of Connecticut*

Differential Mobility Analyzer (DMA) classifies charged molecules and nanoparticles based on their electrical mobility but the classified aerosol has to be transported from the high voltage region of the DMA outlet slit to the detection device which is electrically grounded. The aerosol flow is guided by tubes made of Electro Static Dissipative (ESD) materials that can withstand high voltage while minimizing the aerosol electrostatic losses. Measurements or accurate estimates of such losses are necessary to implement quantitative DMA data inversion and, more broadly, are also relevant in understanding the dynamics of aerosols subject to electric fields in enclosed flows. In this study, we introduce an approach to measure the transmission efficiency of charged nanoparticles inside ESD tubes sequentially subject to a favorable and an adverse axial electric field, as a function of the particles' electrical mobility and the electric fields’ intensity. The approach consists of using a Half-Mini High-Resolution DMA to generate monodisperse aerosols at is grounded outlet tube where the size segregated aerosol stream is split equally into two segmented tubes of equal lengths and internal diameters connected to identical Faraday Cup Electrometers (FCE). All parts of the reference tube are made of stainless steel (SS) tube and are grounded so that only easily predictable diffusion losses affect the measured reference signal. The test tube differs from the reference one because two segments are replaced with parts made in the ESD material under investigation. The ESD segments are separated by a short SS connector segment where we apply the test high voltage. The ratio of the test over the reference FCE signals directly measures the transmission efficiency which quantifies the additional losses induced by the aerosol crossing the adverse and favorable electrical fields before reaching the detector, as well by the electrostatic interactions of the aerosol with ESD. The results show that the transmission efficiency is affected by the ESD material properties, the applied voltage, and some geometric parameters (e.g., ESD segments’ length) in a non-trivial manner. A COMSOL model has been implemented to reproduce the results and gain insight into the particle losses mechanisms.

9IM.21

Scattering Channel Truncation in CAPS PMssa Monitor.

Brian Heffernan, Stephen Jones, Fred Bacon, Andrew Freedman, TIMOTHY ONASCH, *Aerodyne Research, Inc.*

The CAPS PMssa monitor measures both total particle optical extinction and the fraction of that extinction which is scattering – the single scattering albedo. Extinction is measured using an optical cavity defined by two parallel, nearly confocal, high reflective mirrors. Modulated, incoherent LED light travels more than 1 km through the sample before leaking out of the cavity. Particle leaden sample air enters the extinction cell, travels down the cell axis into and out of an integrating sphere, and exits the extinction cell. A transparent glass tube in the middle of an integrating sphere keeps the particle leaden flow separate from the integrating sphere’s inner scattering surface. The integrating sphere acts as an inverse nephelometer, collecting light scattered by particles within the sample cell while the LED is off. Light scattered by particles within the integrating sphere toward the entrance/exit ports is lost, causing truncation of the collected scattering angles in the forward/backward directions. Light scattered by particles in the sample cell, but outside the integrating sphere, can enter into the integrating sphere, partially offsetting light lost through this truncation.

Several research groups have recently investigated the scattering angle truncation in the CAPS PMssa monitor as a function of particle size with varying approaches to model the results, including the effects of the glass tube. We have undertaken a modelling effort based on complete ray-tracing efforts using Zemax Optics Studio to recreate the complete monitor geometry and scattering effects. The ray-tracing model results will be presented, providing insight into the factors controlling the truncation in the CAPS PMssa monitors and enabling sensitivity analyses.

9IM.22

A Solution to New Mobility Particle Sizing Instrumentation and CCN Measurement using Scanning Mobility CCN Analysis (SMCA). Kanishk Gohil, Nahin Ferdousi, AKUA ASA-AWUKU, *University of Maryland, College Park*

Scanning Mobility CCN Analysis (SMCA) is a technique that allows the investigation of the size-specific CCN activity of a given aerosol (Moore et al, 2010). In the past decade, more than 100 publications have used this technique in the laboratory and in the field. The SMCA experimental analysis has contributed substantially to the scientific understanding of size-resolved cloud droplet formation and aerosol hygroscopicity. However, The SMCA technique was built around the 3080 Electrostatic Classifier, a commercial instrument that, along with its software system, is no longer available. SMPS systems utilizing the 3080 Classifier provided the user with a concentration time series measured by the CPC that extended beyond the end of the scan period. This dataset provided SMCA users access to the time stamp of a temporary rise in particle concentration that occurred while the DMA was returning to low voltage. The timestamp of this ‘retrace bump’ was a vital input into SMCA data analysis, enabling researchers to compare and deduce the size resolved CCN activity with a high degree of accuracy. The current electrostatic classifier technology does not provide the ‘retrace’ data needed for SMCA alignment. Without it, the ability to measure size resolved CCN activation on the order of 2 minutes will be significantly hindered. Current topics of CCN research that may change on temporal scales, such as environmental chamber studies or regional mixing state field studies may lose data resolution and valuable analysis that could have been interpreted by the scanning mobility technique. This work summarizes efforts to meet the needs of the CCN community using the newest particle sizing technology and provides a solution to CCN measurement using the latest available electrostatic classifier information. The proposed solution works around the current limitations of the newer SMPS that do not provide a downscan retrace.

9IM.23

A New Oxidation Flow Reactor for Secondary Aerosol Formation Studies. MARKUS NIKKA, Esa Luntta, Oskari Vainio, Erkki Lamminen, Anssi Arffman, *Dekati Ltd.*

Oxidation flow reactors (OFR) are useful tools for studying the photochemical aging of transient emissions sources due to their high time resolution compared to environmental chambers. The high time resolution stems from the short aerosol residence time compared to environmental chambers. OFR equivalent photochemical aging time can be in the order of several days driven by the high concentration of oxidants compared to atmospheric conditions.

In this study, we present characterization results of a new OFR called Dekati Oxidation Flow Reactor (DOFR). DOFR design is similar to the well-studied Tampere University Secondary Aerosol Reactor (TSAR). The main oxidizer in the DOFR is OH-radical that is formed by UV-C (254 nm) photolysis of injected O_3 and H_2O. The characterizations performed for the DOFR include the determination of the equivalent photochemical age range, residence time distributions (RTD), and the secondary organic aerosol yield. In addition, the DOFR was tested by measuring the secondary aerosol formation from passenger cars running in idle.

Particle size distribution and RTD measurements were conducted using the ELPI+ (Dekati Ltd.) and SMPS (TSI Inc.) instruments. The equivalent photochemical age was determined by measuring CO-trace gas concentration (SICK Ltd., Sidor) with UV lights on/off. For the gaseous species, the RTD was measured producing CO-pulses to the reactor inlet and measuring the output pulse shape. Toluene SOA yield was determined and compared with earlier TSAR reactor studies.

The equivalent photochemical age was determined for several %RHs and UV-light intensities as a function of O_3 concentration. The equivalent photochemical age was found to be in the range of 0.2 – 6 days. Calculations were based on previous studies assuming a rate constant of 2.38*10-3 $cm^{-3}s^{-1}$ for the CO to CO_2 reaction. The RTD of particles and gases was found to match closely the modelled laminar flow reactor RTD.

9IM.25

Improving Single-Particle Chemical Composition Analysis through Homogenization of an Excimer Ablation Laser Beam. WENDY FLORES-BRITO, Coty Jen, Ryan Sullivan, *Carnegie Mellon University*

Aerosols are often present as an external mixture of internally mixed particles with complex chemical compositions. The physicochemical properties of individual aerosol particles have been shown to greatly influence ice nucleation, cloud microphysics, and the hygroscopic growth and deposition of inhaled particles. Obtaining chemical composition and mixing state quantitative information through single particle mass spectrometry is limited due to matrix effects and laser–particle interaction issues during the process of laser desorption/ionization (LDI) of particles. Homogenizing the LDI's laser beam is a necessary measure to improve the laser–particle interactions and a key step towards obtaining more reproducible and quantitative single particle physicochemical information. A custom–made, variable beam delivery system (BDS) was used to homogenize the 193 nm Excimer LDI laser for the commercially available LAAPTOF (laser ablation aerosol time-of-flight) mass spectrometer. Un–homogenized, homogenized, and collimated beam profiles were captured and analyzed with a beam profiling camera and software. Visual and quantitative inspection of the results demonstrated that homogenization was achieved for the homogenized and collimated beam profiles. As an additional quantitative measure of homogenization, the Wilcoxon Rank Sum test of equal medians was utilized to compare each row versus column of the averaged fluence from the beam profiles. The resulting p-value maps used to evaluate the flat-top quality produced by the BDS exhibited a better and more uniform distribution for the collimated case, which would be the beam profile that interacts with the particle beam inside the LAAPTOF. Particle hit fraction and shot-to-shot variance studies were performed to evaluate the system's improvement after homogenization. The similarity of individual particle mass spectra acquired from homogeneous test particles was assessed with and with out the BDS homogenization of the LDI laser beam. These promising results will lead to more reproducible and quantitative online aerosol particle analysis.

9IM.27

Coupling of a Thermal-optical Carbon Analyser (TOCA) to High Resolution EI/PI Mass Spectrometry: Unravelling the Molecular Organic Signature and Oxidation State of Aerosol Samples. RALF ZIMMERMANN, Hendryk Czech, Kevin Schnepel, Marco Schmidt, Patrick Martens, Thorsten Streibel, Judith Chow, John Watson, Andreas Walte, Sven Ehlert, *Helmholtz Zentrum München and University of Rostock*

Carbonaceous material in particulate matter (PM) is charcterizable by the organic/elemental carbon content (OC/EC), measured by Thermal-Optical Carbon Analysis (TOCA). The TOCA information-yield can be extended by evolved gas analysis (EGA) by mass spectrometry (Grabowsky et al.-2011; Diab et al.-2015, Miersch et al.-2019a/b). Health-relevant polycyclic aromatic hydrocarbons (PAH) are detectable by resonance-enhanced multiphoton ionization (REMPI)-TOFMS. Here, concept and instrument for an improved TOCA/EGA-TOFMS instrument is presented. Quasi-simultaneous EI and REMPI detection of desorbed molecules by high-resolution TOFMS is realized, enabling detection of both, molecular PAH-information and the oxidation state of organic PM (similar to high-resolution AMS). A quadrupole mass spectrometry approach (qMS) with electron ionization (EI) was privously introduced by Riggio et al. (2018), providing quantitative results on organic matter, nitrate and sulfate, aiming to transfer fragmentation tables from online aerosol mass spectrometry (Canagaratna et al.-2007) to offline filter-analysis. However, no information on the carbon oxidation-state is otainable because qMS cannot provide sufficient mass resolution to distinguish between key isobaric ions, such as $C_3H_7^+$ and $C_2H_3O^+$ at m/z 43. In this work EGA was done via on-line sampling from the TOCA-quartz oven. Ions were generated alternating by EI (70 eV) and REMPI (248 nm). Ion were detected by reflectron-TOFMS with a mass resolution of ~2,800. The high mass resolution allows the separation of many hydrocarbon-/oxygenate-isobars, e.g., for atmospherically aged spruce combustion emissions, a decrease in hydrocarbon-like fragments (e.g. $C_3H_7^+$) can be observed, whereas oxygenate-ions (e.g. $C_2H_3O^+$ and CO_2^+) are noticeably increased. Simultaneously, the selective REMPI method addresses PAH and thus indirectly the carcinogenicity of the organic aerosol-component (Miersch et al.-2019b).

Reference list:
[1] Canagaratna et al., Mass Spectrom. Rev. 26.2 (2007): 185-222.
[2] Diab et al., Atmos. Meas. Techol. 8.8 (2015): 3337-3353.
[3] Grabowsky et al., Anal. Bioanal. Chem. 401.10 (2011): 3041-3044.
[4] Miersch et al. (a), Fuel 236 (2019): 1465-1473.
[5] Miersch et al. (b), Sci. Tot. Environ. 686 (2019): 382-392.
[6] Riggio et al., J.Air Waste Manag. Assoc. 68.5 (2018): 463-476.

9IM.28

Dependence of Pulse Height Distribution on Particle Size, Composition, and Concentration for 1-7 nm Particles. DARREN CHENG, Chongai Kuang, Coty Jen, *Carnegie Mellon University*

New particle formation (NPF) describes the process where gas-phase molecules in the atmosphere nucleate at ~1nm and grow into stable particles. In order to study NPF events and quantify particle nucleation and growth rates, particle size distributions down to 1 nm are required. The most common instrument to perform these measurements is with a scanning mobility particle sizer (SMPS). However, SMPSs scan through particle sizes and therefore do not provide continuous measurements of a single particle size. SMPSs are also reliant on charging particles which is challenging due to extremely low and highly uncertain charging efficiencies for sub-10 nm particles. Here we present pulse height analysis (PHA) of a water-based MAGIC condensation particle counter (CPC) coupled with a diethylene glycol growth tube to measure near-instantaneous size distributions of particles between 1 and 7 nm. The PHA technique provides information on the sampled particle size distribution by relying on the differential condensational growth of particles through a CPC growth tube. Our results show that the pulse height distributions are dependent on particle size, composition, and concentration. For example, sodium chloride particles display a small shift in distribution to larger pulse heights between 1 – 2 nm. In contrast, mode pulse heights from grown ammonium sulfate particles continuously shift monotonically throughout the 1 – 7 nm range. We present how each factor influences the predicted particle size distribution measured from PHA. Overall, our results will improve the accuracy of the PHA technique in measuring sub 10 nm size distributions.

9IM.29

Low-Cost Black Carbon Detection from Beta Attenuation Monitors Using Image Reflectance Based Method. ABHISHEK ANAND, Albert Presto, Suryaprakash Kompalli, Eniola Ajiboye, *Carnegie Mellon University*

Exposure to ambient air pollution accounts for 4.2 million deaths annually. Yet, air quality information is inadequate in many densely populated lands for evidence-based policymaking, especially in the Global South. A critical need is better quantification of fine particulate matter ($PM_{2.5}$) composition, which can in turn be used to identify crucial pollutant sources. A major barrier is the high capital and operational costs of research-grade monitors. This study investigates a cost-effective way to leverage existing monitors to expand the limited air quality dataset in these areas. The US Department of State collects air pollutant data at US Embassies around the world to inform US personnel and citizens of air quality overseas. These measurements use Beta Attenuation Monitors (BAMs) to measure hourly ambient $PM_{2.5}$ concentrations. BAMs collect $PM_{2.5}$ onto a filter tape and estimate particle concentrations by measuring attenuation of beta rays using the Beer-Lambert law. We utilize these BAM tapes to determine hourly ambient black carbon (BC) concentration. Each filter tape spot is individually photographed with a cell phone camera on a reference card containing a set of predefined grayscales corresponding to different BC concentrations. The image is then processed through a custom computer-vision Python script, which performs spatial correction, adjusts for lighting variations, locates the filter spot and then compares its red-light reflectance with that of the grayscales on the reference card to estimate BC concentration. The method was calibrated using filters with known BC concentrations determined from co-located aethalometer and offline thermal-optical EC measurements. The limit of detection is approximately 0.2 $\mu g.m^{-3}$ for 1-hr samples. This presentation will show validation of BC estimates from BAM tapes with EC at a US EPA's Chemical Speciation Network site in Pittsburgh, and analysis of BAM tapes collected at the US Embassies in Addis Ababa, Ethiopia, Abidjan, and Côte d'Ivoire.

9IM.30

A Novel Approach to Calibrate a Photoacoustic Absorption Spectrometer using Monodispersed Gold Nanoshell. YINGJIE SHEN, Shane Murphy, Matthew Burkhart, Gavin McMeeking, Bryan Rainwater, *University of Wyoming*

A new technique for calibrating multi-pass photoacoustic aerosol absorption spectrometers (multi-pass PAS) has been developed using monodisperse absorbing gold coated silica nanoshells. This is the first time a monodisperse particle is found and utilized in the calibration for multi-pass PAS. In this new approach, gold coated silica nanoshells are atomized and measured simultaneously with a multi-pass PAS and a Single-Particle Soot Photometer – Extended Range (SP2-XR) instrument. Gold nanoshells absorb from near-UV to near-IR wavelength and the incandescence channel from SP2-XR can distinguish and count gold nanoshells from other pure scattering aerosols from solution, therefore it is an ideal calibration substance for multi-pass PAS operated at multiple wavelengths. Gold nanoshells are commercially synthesized at well-defined sizes, together with the know refractive index, we are able to calculate the theoretical absorption coefficient via Mie theory and then further calibrate multi-pass PAS. This approach may be utilized in a system with both Differential Mobility Analyzer (DMA) and Condensation Particle Counter (CPC) as a replacement for the SP2-XR, but it will increase 27% error due to the miscounting for non-gold containing particles. Other Optical Particle Counter may replace the SP2-XR and only increase 5% error once the correct bins are selected. The advantage of this new calibration substance includes known size and refractive index, stability over a long period and with different capping agent, and absorption at a broad range of wavelength, which is convenient to calibrate at multiple wavelengths.

9IM.31

First Results from the Groundbased Fog and Aerosol Spectrometer. DARREL BAUMGARDNER, Dagen Hughes, Paul Zieger, Mike Carrabus, Almuth Neuberger, *Droplet Measurement Technologies*

Droplet Measurement Technologies LLC (Droplet) has recently developed a single particle optical spectrometer that is a ground-based version of Droplet’s airborne Cloud and Aerosol Spectrometer with Polarization (Baumgardner et al., 2001,2014). The Ground-based Fog and Aerosol Spectrometer (GFAS) measures directly, or derives: 1) Equivalent optical diameter (EOD) of particles 0.5 – 60 µm, 2) Number and volume concentrations > 3000 cm-3, 3) Shape factor using polarization detection, 4) complex refractive index (CRI). The shape factor is used to differentiate liquid droplets from ice crystals, dust particles or ash from biomass burning. The complex refractive index determines if fog droplets are mixed with either dissolved or insoluble material.

The GFAS was recently deployed for three months in the PO Valley where it measured a broad variety of events where fog was mixed with fog and the CRI was clearly linked to air mass origin, i.e. whether the air was coming from cleaner or more polluted sources.

This presentation will highlight the many unique features of the GFAS, illustrated with field observations.

9IM.32

Real-Time Non-invasive Measurements of Aerosol Flow in the Laboratory. JULIE PONGETTI, Nick Collings, Jonathan Symonds, Chris Nickolaus, *Cambustion Ltd*

Almost all aerosol experiments include a need to measure gas flows accurately, either to check that a measurement instrument is operating correctly, or to directly correct a measured parameter. Many general laboratory methods exist for measurement of gas flow – including, rotameters, soap bubble, orifice, and more. However, these are usually not ideal for aerosol laboratory use as they may variously be damaged by aerosol particles, have the flow reading affected by the aerosol particles, affect the aerosol itself. Here we focus on the principle of pressure drop through an orifice and investigate the challenges involved in adapting this well-established flow measuring technique to aerosol flows.

The mass flow of a gas of known properties can be related to its pressure drop through an orifice of known geometry, based on local temperature and pressure conditions. This relationship remains valid for dilute aerosol flows, but over time particles accumulate on the orifice, affecting its discharge coefficient and hence the calibration curve.

The geometry upstream of the orifice plays a role – amongst others – in determining the location and rate of the particle accumulation. Restoration of the orifice initial performance is possible upon cleaning of the flow duct, where mechanical removal of the accumulated particles by use of a brush was found to be most effective.

These initial results were successfully used to develop a commercial instrument, the Cambustion AF10 Aerosol Flowmeter. The latest tests carried out on the new product show that a one-point empirical calibration adjustment to the physical model for each orifice is sufficient to achieve a 2% accuracy on the whole range of flow rates covered. Endurance tests with highly loaded aerosols also show the effectiveness of the integrated cleaning brush, which allows performance to be guaranteed over long experiments while causing minimal disruption (< 1 s).

9IM.33

Using the Aerodynamic Aerosol Classifier (AAC) as a Low-Pass Separator. JULIE PONGETTI, Chris Nickolaus, Jonathan Symonds, *Cambustion Ltd*

The Aerodynamic Aerosol Classifier (AAC) was originally designed to transmit particles of a selected aerodynamic diameter in the range 25 nm to >5 µm. This is achieved by passing the polydisperse aerosol through a rotating cylinder (the classifier) where the particles experience opposing centrifugal and drag forces and only those of the selected size follow the correct trajectory into the sample outlet.

While particles larger than the setpoint are lost in the AAC classifier, those smaller than the setpoint remain suspended and can be considered a useful aerosol. It is therefore of interest to investigate the use of the AAC as a low-pass separator by recovering the sheath aerosol which contains all particles smaller than the setpoint. This is possible by disconnecting a readily accessible pipe at the back of the instrument.

Due to the limitations on the flow rates of the sample and sheath, the aerosol will also be diluted. To minimise dilution, it is necessary to use low sheath:sample ratios, hence decreasing the sharpness of the cut-off. Given the extremely high resolution offered by the AAC for monodisperse classification, this reduction is not a concern for a low-pass application.

The transmission efficiency was investigated for different combinations of sample and sheath flows using a second, standard AAC to either scan the output of the low-pass AAC or produce a monodisperse challenge aerosol.

To minimise dilution while maintaining a good resolution, a sheath:sample flow ratio around 3:1 is recommended. Under these settings, the AAC as a low-pass separator showed a sharp cut-off and excellent dilution-corrected transmission (>90%) between 200 nm and 2 µm.

Overall, the AAC can be easily converted into a low-pass separator with freely adjustable setpoint across over one order of magnitude in aerodynamic diameter – offering a flexible alternative to impactors and cyclones.

9IM.34

Surface Enhanced Optical- and Atomic Force Microscope-Photothermal Infrared and Raman Microspectroscopy Enables Observation of Individual Ultrafine Aerosol Particles.

YAO XIAO, Ziying Lei, Andrew Ault, *University of Michigan*

Atmospheric aerosol particles have a large impact on climate by scattering solar radiation and nucleating cloud droplets and ice crystals. These climate impacts are driven by single particle physicochemical properties and non-destructively characterizing individual particles spectroscopically <1 µm in diameter remains challenging. In previous studies, our group has successfully characterized submicron particles using Optical Photothermal Infrared Spectroscopy (O-PTIR), Raman microspectroscopy, and Atomic Force Microscope - Photothermal Infrared Spectroscopy (AFM-PTIR) to characterize aerosol particle under ambient temperature and pressure. However, prior PTIR measurements of individual particles still struggled with detecting key species within submicron (< 1 µm) for O-PTIR/Raman and ultrafine (< 0.1 µm) for AFM-PTIR. Herein, we apply surface enhanced IR spectroscopy (SEIRS) to detect trace organic and/or inorganic species in particles below the diameters previously measured by these instruments, respectively. Gold substrates were used to enhance the signal due to enhanced reflection and plasmon resonances. Organic and inorganic functional groups were characterized in laboratory-generated and ambient aerosol particles with aerodynamic diameters < 500 nm and 20 nm for O-PTIR/Raman and AFM-PTIR, respectively. Spectral mapping at a specific wavenumber was also used to characterize SEIRS spatial resolution. The results showing enhanced detection limits and spatial scales for detecting key species in aerosol particles with SEIRS demonstrate improved chemical characterization of aerosol particles below the traditional size range of infrared microscopy.

9IM.35

The Effect of Filter Storage Techniques on Thermal and Optical Degradation of Combustion Aerosol Samples.

CHASE GLENN, Omar El Hajj, Kruthika Kumar, Rawad Saleh, *University of Georgia*

Aerosols are often collected on filters for offline analyses weeks after sample collection. Current practices involve wrapping filters with aluminum foil and storing in a freezer to prevent sample degradation. However, evidence supporting these practices is lacking. Here, we examine the effect of thermal and photo degradation on aerosol samples generated from the combustion of pine needles and toluene. The aerosols were collected on quartz and Teflon filters. The quartz filters were analyzed for their organic and elemental carbon content using an OCEC analyzer. The Teflon filters were extracted, and the imaginary part of the refractive index (k) was retrieved from light-absorption measurements using a UV-vis spectrometer. Each filter was divided into four pieces. One was analyzed immediately (control), and the others were stored for a month at three conditions: (A) covered and in a freezer, (B) covered at room temperature, and (C) uncovered at room temperature.

For both pine and toluene combustion aerosol, storage condition A ensured OC/EC results identical to control. On the other hand, B and C led to reduction in OC1 fraction, especially at C, which can be attributed to evaporation of semi-volatile OC. For pine combustion, k at 422 nm (k_{422}) at A and B were close to control. On the other hand, k_{422} increased by 21% for C, suggesting that the evaporated OC is less absorptive than the residual OC, leading to an overall increase in k_{422}. For toluene combustion, k_{422} decreased relative to control by 20%, 18%, and 10% for A, B, and C, respectively. This can be explained by two competing effects: (i) degradation of chromophores at all conditions, and (ii) evaporation of the less absorbing OC fraction in C leading to larger k_{422} compared to A and B.

9IM.36

Comparison of Aerosol Loss Effects in a Continuous-Flow Atmospheric Chamber Under Different Operational Configurations. KATHERINE PIERRE-LOUIS, Erin O'Leary, Bruno Loyola San Martin, Joseph Woo, *Lafayette College*

Laboratory-scale atmospheric chambers are a ubiquitous method for the characterization of aerosol emission and growth. To properly account for the overall mass balance of specific aerosol concentrations, losses to the internal walls and surfaces, β, must be quantified prior to measurement. This loss term largely assumes constant, uniform mixing within the chamber airspace; however, for smaller chambers, local convection due to entrance and exit flow effects may result in shifts to the overall mixing that occurs in practice. This study quantifies and statistically compares the wall loss factors of a $0.8m^3$ continuous-flow chamber under a variety of operational conditions (total flow throughput, ambient RH, attached equipment actively pulling exit flow.) It was found that while connection to active vacuum pump operation had no statistically significant effect, air flow rate, aerosol diameter, and relative humidity had a statistically significant effect on wall loss coefficients.

9IM.37

Calibration of a Single-Particle Soot Photometer with Different Soot Surrogates. JAMES HENRY, Dongli Wang, Andrew Metcalf, *Clemson University*

The Single Particle Soot Photometer (SP2) uses a high-powered laser to heat absorbing aerosol particles, including black carbon, to the point of incandescence. The energy given off as incandescence can then be used to determine the mass of individual particles present in the air sample. To determine the bulk mass or number concentration of particles in the air, these individual particles are added together. Thus, any errors or uncertainties in the single-particle data can compound to give larger errors in the derived bulk concentrations. Therefore, careful calibration with the proper material(s) is required to ensure accurate data from the SP2 instrument.

The purpose of this study is to determine the best calibration method(s) and material(s) for the SP2. Because materials and chemicals available previously are no longer available from the same manufacturers, data from several black carbon surrogates (i.e., fullerenes) that are currently available are used to determine whether different chemical structures (e.g., C60 and C70 at different levels of purity) lead to distinct incandescence signals that would change the SP2 calibration factors. The data analysis procedures are also examined in detail to determine if the peak height detection in the raw signals may mask additional information on single-particle chemical structure.

9IM.38

Aerosol Raman Spectrometer for Near Real-time Measurement of Aerosols with High Specificity in Workplace Atmospheres. Surendra Devarakonda, Orthodoxia Zervaki, PRAMOD KULKARNI, *Centers for Disease Control and Prevention, NIOSH*

We describe design and development of a hand-portable, battery-operated Aerosol Raman Spectrometer for near real-time measurement of chemical components of occupational aerosols. The prototype instrument employs, an automated cyclical "collect-analyze-ablate" scheme, where airborne particles are first sampled and collected on an electrode as a small deposit, following analysis for target analyte using Raman spectroscopy, and are subsequently ablated to collect the next batch of particulate sample. The semi-continuous scheme offers unattended and automated sampling and quantification of aerosol chemical component using Raman spectroscopy. Laboratory experiments were conducted to characterize time-resolution, detection limits, uncertainty, and dynamic range of measurement for various occupational aerosols of interest, such as respirable crystalline silica (RCS), titanium dioxide (TiO2), particulate Cr (VI), diesel particulate matter (DPM), graphene, and single-walled carbon nanotubes (SWCNTs). The detection limits for respirable crystalline silica (RCS) and TiO2 were found to be approximately 200 ng and 27 ng, respectively, which is approximately 2 to 3 orders of magnitude lower than those of the standard methods using the same aerosol sample collection time. The high specificity of the method was also demonstrated by distinguishing two polymorphs of TiO2, rutile and anatase, in a mixed aerosol. Ability to measure in near-real time was demonstrated by continuously measuring transient aerosol concentrations. The method was also successfully extended to measure crystalline silica content of aerosol samples obtained from hydraulic fracturing workplace that had relatively complex particulate matrix. While sample fluorescence can limit the applicability to a wide range of aerosol types, the study does demonstrate the potential of this hand-portable instrument to provide on-site near real-time quantification with high specificity and sensitivity for occupationally relevant aerosols.

9IM.39

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

The ability of an atmospheric aerosol particle to take up water or to participate in heterogeneous reactions is highly influenced by its phase state – solid, semi-solid, or liquid. The changes in phase state can be predicted by glass transition temperature (T_g), as particles at temperatures below their T_g will show solid properties, while increasing the temperature above their T_g will allow for semi-solid and eventually liquid properties. Historically, measurements of the T_g of bulk materials have been studied in order to model the phase states of aerosols in the atmosphere; however, these methods only permit an estimation of aerosol Tg based on their bulk chemical composition. Determining the T_g of individual particles will allow for more accurate model predictions of aerosol phase state. 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_g of individual secondary organic aerosol (SOA) particles generated from the reactive uptake of isoprene-derived epoxydiols (IEPOX) onto acidic ammonium sulfate aerosol particles. NanoTA works by using a specialized AFM probe which can be heated while in contact with a particle of interest. As the temperature increases, the probe deflection will first increase due to thermal expansion of the particle followed by a decrease at its melting temperature (T_m). The T_g of the particle can then be determined from Tm using the Boyer–Beaman rule. We compare the T_g of the SOA particles formed from IEPOX uptake onto ammonium sulfate particles with different initial aerosol pH values, as well as under a range of oxidant exposure conditions. Our measurements will allow for more accurate representations of the phase state of aerosols under a range of atmospheric conditions.

9IM.40

Field Demonstration of a Wearable Particulate Matter and Volatile Organic Compound Monitor. JESSICA TRYNER, Emilio Molina Rueda, Jane Andales, Casey Quinn, Christian L'Orange, Ellison Carter, John Volckens, *Colorado State University*

Exposures to particulate matter (PM) and volatile organic compounds (VOCs) pose numerous health risks. These exposures vary in space and time both within and between microenvironments (occupational, residential, transit, etc.). The highest-fidelity estimate of personal risk is obtained by sampling air pollutants in a person's breathing zone; however, data on personal PM and VOC exposures are limited—in part due to the cost and logistics of outfitting individuals with wearable sampling equipment. To improve the feasibility and scalability of personal PM and VOC exposure assessment, we developed a small (200 g), quiet (< 55 dB), wearable monitor that actively samples PM onto a filter and VOCs onto a thermal desorption tube. The monitor also includes a GPS and a suite of low-cost sensors to collect spatiotemporally-resolved data on environmental conditions (e.g., temperature and light) as well as PM and VOC levels. In a pilot study, we paired our new monitors with conventional personal sampling equipment to assess "at-work" and "away-from-work" exposures to $PM_{2.5}$ and VOCs for five employees at an agricultural research facility. Exposures varied among employees with different job tasks. Participants were exposed to one-week average $PM_{2.5}$ concentrations of up to 82 $\mu g\ m^{-3}$ at work. Time-resolved sensor data suggested that at-work exposures to $PM_{2.5}$ mass were dominated by windblown dust. Work shift-averaged personal exposures to BTEX (benzene, toluene, ethylbenzene, and xylenes) measured using the new monitors agreed with exposures measured using conventional personal sampling equipment (Spearman's correlation coefficient = 0.98; slope of line fit using Deming regression = 0.79). Time-resolved sensor data were used to identify specific at-work locations and activities associated with higher VOC exposures. Personal exposures to $PM_{2.5}$ and BTEX were typically lower when participants were away from work. These results illustrate the value of combining time-integrated pollutant samples with low-cost sensor data to gain knowledge on the timing and sources of personal exposures to air pollution.

9IM.41

Insoluble Residues from Isoprene-Derived Secondary Organic Aerosol Determined by Nanoparticle Tracking Analysis and Microspectroscopy Techniques. REBECCA PARHAM, Alison Fankhauser, Jia Shi, Madeline Cooke, Jin Yan, Cara Waters, Yao Xiao, Katherine Kolozsvari, N. Cazimir Armstrong, Zhenfa Zhang, Avram Gold, Jason Surratt, Andrew Ault, *University of Michigan*

Atmospheric aerosols significantly offset positive radiative forcing due to their contributions as cloud condensation nuclei (CCN) and ice nucleating particles (INPs). The cloud-aerosol-precipitation interactions in the atmosphere are determined by physical and chemical properties of aerosol particles, which can undergo many cycles of droplet activation and subsequent drying before dry or wet deposition from the atmosphere. Secondary organic aerosol (SOA) is an abundant class of aerosol and has been previously shown to contribute to aerosol formed from cloud processing. Isoprene-derived secondary organic aerosol SOA (iSOA) is a particularly important class of aerosol involved in cloud processing. iSOA has both soluble and insoluble components, but there has been a measurement gap in characterizing the insoluble components, as most analyses have focused on soluble components. These measurements are needed as previous research has suggested that insoluble components could be important with respect to CCN and INP formation.

Herein, we analyze the insoluble components of SOA generated from the reactive uptake of IEPOX onto acidic seed particles (ammonium sulfate + sulfuric acid at different ratios for different pH conditions) in an atmospheric chamber. We characterize the size distributions and chemical composition, using NanoParticle Tracking Analysis (NTA), Raman microspectroscopy and atomic force microscopy infrared (AFM-IR) spectroscopy as a function of sulfate aerosol seed pH. These insights may help understand aerosol properties after cloud cycling in the atmosphere.

9IM.42

Evaluation of Oligomeric Content in Secondary Organic Aerosol Using Matrix-Assisted Laser Desorption Mass Spectrometry (MALDI-MS).

CARA WATERS, Madeline Cooke, Alison Fankhauser, Jin Yan, Rebecca Parham, Katherine Kolozsvari, Yao Xiao, N. Cazimir Armstrong, Zhenfa Zhang, Avram Gold, Jason Surratt, Andrew Ault, *University of Michigan*

Secondary organic aerosol (SOA) is key to our climate, affecting Earth's radiative balance both indirectly and directly. Understanding the chemical composition and properties of SOA are crucial to accurately predict their concentrations and ultimately their impact on climate in models. Multiphase chemical reactions in the atmosphere have been found to form a variety of low-volatility, high-molecular-weight species, or oligomers. Although oligomers may constitute a large portion of SOA, they are not well understood. Most analytical techniques are unable to detect such high-mass organic species, so their formation and degradation mechanisms are still in need of investigation. Herein, we present a method using matrix-assisted laser desorption ionization mass spectrometry (MALDI-MS) to determine the oligomeric content of aerosol particles. We apply the method to analyze SOA particles formed from reactive uptake of IEPOX onto acidic ammonium sulfate seed particles during atmospheric chamber experiments. We compare the oligomeric content of the particles based on key properties, including particle acidity and exposure to oxidants. We compared multiple sample collection methods, including impaction into deionized water using a Liquid Spot Sampler (Aerosol Devices) and direct impaction onto a sampling plate. Our work will provide insight about the formation of oligomers in the atmosphere, which will allow better modeling of their climatic impact.

9IM.43

Numerical Assessment of Particle Collection Efficiency of an Adaptor Connecting a Viable Virus Aerosol Sampler and a Point-of-Care Detector.

AMIN SHIRKHANI, Sripriya Nannu Shankar, Carlos Mazanas, Z. Hugh Fan, Chang-Yu Wu, *University of Florida*

Collection and on-the-spot detection of respiratory virus aerosols allow quick actions to minimize exposure. In this study, we carried out computational fluid dynamics (CFD) simulations of aerosol flows in an adaptor, which facilitates the integration of the viable virus aerosol sampler (VIVAS) and a valve-enabled lysis, paper-based RNA enrichment, RNA amplification device (VLEAD), to numerically investigate its collection capability. This adaptor, when attached to VIVAS during sampling, functions as a collector. After sampling, the collection medium containing virus particles is transferred directly to VLEAD with the help of a ball valve located at the bottom of the adaptor, for point-of-care analysis. Ansys FLUENT (Fluent 2021 R2) was used to 1) generate tetrahedron mesh (with approximately 1.2 million elements) and 2) study particle trajectory and impaction on liquid collection medium. In our CFD model, we used steady-state, pressure-based, isothermal, laminar air flow with a velocity of 0.5 m/s at the inlets (eight cylindrical tubes) under ambient operating conditions. Lagrangian approach was utilized for particle tracking, and “trap” condition was set for all the surfaces except for inlets and outlets, which are defined as “escape”. Monodisperse water droplets of varied sizes uniformly distributed at the inlet of the tubes were simulated for their flow through the tubes, and then toward the collection medium surface, through 24 nozzles. Droplets' trajectories were calculated until they left the domain (escaped from the outlet) or trapped on the liquid surface. Based on the number of particles trapped on the surface of the collection medium over the total number of particles at the inlet, physical collection efficiencies of 95.8%, 98.1%, and 100% were recorded for droplet sizes of 0.1, 1, and 5 µm, respectively. Comparison with experimental data to validate these results will be reported at the conference

9NM.1

Antimicrobial Spray-dried Nanoparticles-in-Microspheres.

ALBERTO BALDELLI, Hale Oguzlu, Hashem Etayash, Robert Hancock, Feng Jiang, Anubhav Pratap-Singh, *The University of British Columbia*

Bacterial infections are treated with antibiotics; however, bacteria can develop antibiotic resistance, leading current researchers to explore alternative strategies. Spray-dried nanoparticle-in-microsphere formulations, made of aluminum oxide nanoparticles (Al_2O_3 NPs), zinc oxide (ZnO), zinc oxide NPs (ZnO NPs) and cellulose nanocrystals (CNCs), with effective antimicrobial and antibiofilm activity against Gram-negative and Gram-positive bacteria are described. We validated that the antimicrobial properties of metal oxide nanoparticles-in-microspheres is higher than each of the raw materials used in any formulation tested. We verified the impact of the ratios in the components of the formulations on the antimicrobial properties and toxicity of metal oxide nanoparticles-in-microspheres. A formulation made of CNCs (weight % ≥ 0.75%) and an equal weight % of Al_2O_3 NPs and ZnO NPs (~ 0.25% per type of NPs) generated the highest antimicrobial and antibiofilm activity (Gram-positive bacteria (both methicillin-resistant Staphylococcus aureus (MRSA) USA300 LAC, and MRSA SAP0017) and Gram-negative bacteria, including E. coli ATTC489, P. aeruginosa PAO1, and Acinetobacter baumannii ATTC5015). Moreover, the toxicity of these formulations, tested against peripheral blood mononuclear cells, was very minimal (≤500 µg/ml) and significantly lower than the toxicity of the metal oxide NPs when tested alone.

9NM.3

Prediction of Mass Yield, Morphology and Composition of Soot Particles Generated by Pyrolysis of Methane.

MOHAMMAD ADIB, Mohammad Reza Kholghy, *Carleton University*

Soot (black carbon) and Carbon Black are carbonaceous nanoparticles formed during pyrolysis of hydrocarbons. Estimating the mass yield and properties of generated particles is an arduous task due to the complex physics of soot formation. Here, we develop a plug flow reactor code based on a simple Monodisperse Population Balance Model (MPBM) that tracks number concentration, surface area, carbon and hydrogen content of particles to predict mass yield, morphology, and composition (hydrogen/carbon ratio) of particles formed during pyrolysis of ethylene in a flow reactor. The model accounts for the soot inception by the reactive dimerization of polycyclic aromatic hydrocarbons (PAH), and its surface growth by hydrogen abstraction acetylene addition (HACA) as well as the adsorption of PAHs on particle surface. The scaling power-laws from Discrete Element Model (DEM) are used to describe the fractal-like structure of soot agglomerates. The simulations demonstrated the accuracy and robustness of the developed model. The evolution of number concentration, mass, and mobility and primary particles are in good agreement with predictions sectional model population balance model (SPBM). The final mass yield, and mobility diameter were also predicted within 20% of the measurements, but the mobility diameter was underpredicted by 45%. The model can be easily interface with computational fluid dynamic (CFD) to model soot formation in combustion devices and used a process design and optimization tool for synthesis of agglomerate nanoparticles.

9NM.4

Aerosol Synthesis of Metal-Organic Frameworks Under Low Pressures. JIANPING CHEN, Zan Zhu, Da-Ren Chen, Wei-Ning Wang, *Virginia Commonwealth University*

The development of synthesis methods of metal-organic frameworks (MOFs) creates many new opportunities in the utilization of porous materials. Recently, a microdroplet spray process for MOF synthesis has been developed. This aerosol process offers a way for engineering nanoscale MOFs with controlled structures and properties for applications such as gas adsorption. In this aerosol process, atomized microdroplets of a MOF precursor solution undergo well-controlled physiochemical transformations, with each microdroplet serving as a microreactor. Reaction parameters, such as temperature, pressure, can have a strong influence on solvent evaporation, and eventually, affect the rate of nucleation and growth of MOFs. In particular, the synthesis pressure is of importance since it can determine the flow regime of aerosol droplets (i.e., continuum or free molecular). The evaporative cooling effect occurs in this free molecular regime (i.e., Knudsen number $Kn \geq 1$), which complicates the heat and mass transfer accounting for the MOF formation process. Nevertheless, this problem remains complex both from a computational and experimental standpoint. This work studies the rapid formation of copper-based MOFs under changing flow regimes. Specifically, changes in crystal size, morphology, and orientation, as well as surface oxidation state, are observed with decreasing operating pressure. Heat and mass transfer calculations, accounting for the transition of flow regimes from continuum to free-molecular, suggest that these variations are partially related to different microdroplet evaporation rates. In addition, we found that the dissociation of solvent molecules from MOFs under sub-ambient pressure generates open metal sites which result in high binding affinity for CO_2 molecules. Our study illustrates the synthesis of MOFs under substantially low operating pressures and offers many new opportunities in the controlled synthesis of MOFs for selective gas adsorption.

9NM.5

A Wide Range (0.32° to 177.6°), Multi-angle Light Scattering Setup and Concomitant Analysis Method. Prakash Gautam, CHRISTOPHER M. SORENSEN, *Kansas State University*

We describe a laboratory light scattering apparatus for aerosols covering the scattering angle range $0.32° \leq \theta \leq 177.6°$, involving 46 angles. Two multi-channel detectors are used for nearly simultaneous detection at all angles. Given some extremely small angles, analysis of the data from this device requires Q-space analysis which provides a geometric perspective using the logarithm of the independent scattering variable, the scattering wave vector, q. On the other hand, with the extreme large angles, the scattered intensity is best viewed by plotting linearly versus the independent variable, the scattering angle, θ. Thus, the data obtained from our setup is plotted both logarithmically in Q-space and linearly in θ-space. The combined methods yield a comprehensive description of the scattering. See: Rev. Sci. Instrum. 92, 113105 (2021); https://doi.org/10.1063/5.0068318.

9NM.6

A Facility to Mass Produce Multilayer Graphene and Carboxylate Graphene. CHRISTOPHER M. SORENSEN, Stephen Corkill, Ray Estes, Shusil Sigdel, Justin P. Wright, Arjun Nepal, Stefan Bossmann, Russell Reynolds, *Hydrograph Clean Power, Inc.*

We describe our nascent facility for the mass production of high-quality, multi-layer, turbostratic graphene via an explosion aerosol synthesis. The facility occupies ca. 12,500 ft^2 including a production area, laboratory and office space. We have scaled up our original bench scale explosion reactor to an automated production device for graphene. The device produces approximately one kilogram per hour with a 3.5m^2 footprint. The reaction that makes the graphene is exothermic, unlike any other method to make graphene. Hence, it is much more energy efficient than other production method. Our production method has been certified by the international Graphene Council. Our facility also has two 2000L stirred reactors for the production of core-shell graphene oxide via a Fenton oxidation of the graphene we make. The graphene oxide has no intercalated oxygen, unlike every other graphene oxide, and has a homogeneous reactive shell of carboxylic acid groups. Thus an uncompromised graphene can be rationally targeted via chemistry to a wide variety of application.

9RA.1

Why Is the Copious Aerosol Observed in the Boundary Layer in June at Ascension Island So Highly Absorbing of Sunlight? AMIE DOBRACKI, Paquita Zuidema, Arthur J. Sedlacek, Maria Zawadowicz, *University of Miami*

Ascension Island, located at the northwest corner of the southeast Atlantic Ocean stratocumulus deck (-7.95° N, -14.36° E), receives biomass burning aerosol at the surface during much of the year despite its remote location. Zuidema et al., 2018 use in situ data from the DOE's Layered Atlantic Smoke Interactions with Clouds (LASIC) campaign to show that the month of June has the highest absorption per unit mass of black carbon, the lowest single scattering albedo, the highest absorption angstrom exponent, and the highest hygroscopicity, of the June-October biomass-burning season. This occurs despite the highest smoke loadings being measured in August, not June, at Ascension Island. Here we further investigate the chemical and physical properties alongside the optical properties of biomass burning aerosol during June 2017, towards explaining this annual phenomenon. Data from an aerosol chemical speciation monitor indicates that the chemical composition of the smoky time periods in the boundary layer contain only slightly more black carbon than in August (12% versus 11%), but that overall this is approximately twice the fractional percentage of free-tropospheric smoke plumes. Fractionally more sulfates and less organic aerosol are measured than in August-September. The meteorology is similar between smoky and clean time periods in June, and this is exploited to conclude that most of the sulfates during the smoky time periods are associated with biomass-burning aerosol, not sea spray. We hypothesize the properties of the June smoke aerosol reflects black carbon that is more thickly coated than in other months, and will use this presentation to assess this hypothesis, and counterhypotheses based on variations in fire source and transport pathways to Ascension.

9RA.2

Aerosol Properties over the Remote Marine Western North Atlantic Ocean during NAAMES. FRANCESCA GALLO, Kevin Sanchez, Bruce Anderson, Matthew Brown, Ewan Crosbie, Carolyn Jordan, Claire Robinson, Taylor Shingler, Michael Shook, Thornton Matthew, Elizabeth Wiggins, Ryan Winslow, Luke Ziemba, Richard Moore, *NASA Langley*

In this study, we provide summary statistics of marine aerosol characteristics and aerosol budget over the Western North Atlantic ocean region, collected during the North Atlantic Aerosols and Marine Ecosystems Study (NAAMES). Remote marine environments, dominated by pristine atmospheric conditions of low aerosol concentrations, are the most impacted by perturbations in aerosol properties and the major constraint to accurate future climate predictions. In this context, between 2015 and 2018, NASA deployed the NAAMES filed campaign with the objective of expanding the knowledge of aerosol properties and key processes in the marine environment. In situ ship- and aircraft-based measurements and airborne-based remote sensing retrievals were coupled during three field campaigns: NAAMES-1 (November 2015), NAAMES-2 (May 2016), and NAAMES-3 (September 2017). Here, we integrate aerosol microphysical, optical, and chemical datasets from the three platforms, and we discuss the spatiotemporal variability of aerosol and aerosol key processes in function of different aerosol loadings and meteorological regimes. Preliminary analysis of the consistency between in situ and remote sensing aerosol observations will also be assessed.

9RA.3

The Use of Federal Reference Sensors, Satellite-Based Instrument Measurements, and Low-Cost Sensors for Temporal and Spatial Analysis of Air Quality in South Carolina. ABI ROBERTS, Christopher Post, Andrew Metcalf, *Clemson University*

Air quality is influenced by a combination of pollutants, particulate matter (PM) being one of the main constituents. PM in the United States is monitored by networks managed at state, local, and tribal levels. Due to the expense of the equipment used for monitoring air quality at a regulatory level, these reference monitors can be sparsely distributed. Ways for increasing the density of coverage of measurements is with satellite-based instruments and low-cost sensors (LCS). While more accessible to both researchers and the public, both have barriers precluding their use in regulatory assessment. Satellite-based instruments measure the extinction of light in the atmosphere that is used to estimate surface-level concentrations of PM. The relationship between PM concentration and light scattering and absorption is highly dependent on the composition, shape, and size of particles in an area, often unknown or uncertain properties. Barriers to the use of LCS are related to their reliability and accuracy, which is influenced by environmental factors such as temperature and relative humidity.

In this talk, ongoing work to link LCS with satellite-based measurements of PM and reference monitors will be discussed. We have previously evaluated a LCS sensor pack developed at Clemson University during a 5-month deployment that we plan to use as part of a dense, LCS network in South Carolina. This talk will examine historical spatial and temporal trends of aerosols in the region, using data collected from the MODIS instrument on the Aqua and Terra satellite compared with surface measurements from reference methods in the South Carolina Department of Health and Environmental Control (SC DHEC) network. Comparisons to the 5-month deployment will also be presented. Finally, this work will be used to inform future studies using a LCS network for ground-based measurements to validate satellite remote sensing of surface-level PM concentrations.

9RA.4

Reconciling Emissions Models with Observed Variability in BVOC Concentrations. DEBORAH F. MCGLYNN, Namrata Shanmukh Panji, Laura E. R. Barry, Xi Yang, Manuel Lerdau, Sally Pusede, Gabriel Isaacman-VanWertz, *Virginia Tech*

Three years of hourly biogenic volatile organic compound (BVOC) atmospheric concentration data have been collected mid-canopy from a measurement tower at the Virginia Forest Lab (VFL), in Fluvanna County, Virginia. The BVOC concentrations were measured alongside chemical fluxes of ozone and nitrogen oxides, and with accompanying meteorological and ecological data. This suite of data allows for a comparison between observed concentrations and modeled emissions. Currently, emissions models do not capture many features of the observed temporal variability, e.g., the models miss observed daytime peaks of highly reactive monoterpenes and do not accurately account for seasonal variability at this site. Emissions of monoterpenes using the Model of Emissions of Gases and Aerosols from Nature (MEGAN) are coupled with a box model, the Framework for 0-D Atmospheric Modeling (F0AM), to reconcile observed BVOC concentrations with estimated emissions. Observational data and the model are compared to identify differences and similarities on temporal scales ranging from hours to years. We explore modifications of the emission model and determine implications for secondary organic aerosol formation modeling.

9RA.5

Measuring Wet Deposition of Semi- Volatile Organic Compounds in and near a Virginia Forest. RAINA LENEAR, Christos Stamatis, Graham Frazier, Gabriel Isaacman-VanWertz, *Virginia Tech*

During precipitation events gas and particle concentrations decline substantially, followed by a recovery period prior to a subsequent precipitation event. We use empirical observations of the decrease in concentration of individual organic compounds during precipitation events to quantify their scavenging rates. Hourly concentrations of gas- and particle-phase compounds were collected by the Semi-Volatile Thermal Desorption Aerosol Gas chromatograph (SV-TAG) at several locations throughout Virginia. These data are coupled with available precipitation data to quantify removal through wet deposition. These data are used to improve understanding of both the direct impacts of wet deposition on aerosol mass loading, through the removal of particle-phase components, and the indirect effects through the removal of potential aerosol-forming gases. Observations will be compared to theoretical estimates and observations from other ecosystems to more broadly understand the influence of wet deposition on present aerosol mass and other important atmospheric chemical processes.

9RA.6

Effect of Precipitation on the Emissions of BVOCs and Their Potential Aerosol Formation. NAMRATA SHANMUKH PANJI, Deborah F. McGlynn, Laura E. R. Barry, Sally Pusede, Gabriel Isaacman-VanWertz, *Virginia Tech*

Over thousands of reactive organic gases are continually emitted into the atmosphere and contribute to the global organic aerosol (OA) loading through complex photochemical oxidation pathways. A significant portion of these chemicals are emitted from biogenic sources during biochemical signaling, response to external stressors, or leaf senescence, etc. The amount of biogenic volatile organic compounds (BVOCs) released by plants during these processes is dictated by complex feedbacks that exist between plants and their environmental conditions. In particular, the effects of precipitation on a forest may drive complex interactions between the biosphere and atmosphere by removing ozone from the atmosphere and depositing it to the surface, and by potentially driving changes in emissions of reactive organic compounds. Consequently, while precipitation is generally considered as a mechanism to remove aerosols and oxygenated gases that might condense to form aerosol, it could also potentially increase aerosol formation indirectly by enhancing emissions of aerosol precursors. Therefore, a quantitative understanding of the impacts of precipitation on atmospheric composition is essential.

Hourly measurements of BVOC mixing ratios and meteorological data are available over three years from a measurement campaign at the Virginia Forest Laboratory (VFL), Fluvanna County, VA. In this study, we explore this interplay by analyzing hourly BVOC data before, during, and after rain events to quantify the impacts of rain events on aerosol formation over short and long time periods. Further, we present our investigations of the interannual variability in these relationships.

9RA.7

Chemical Characterization of Seasonal Brown Carbon in the Indo-Gangetic Plain. POOJA CHAUDHARY, Kyla Siemens, Christopher P. West, Baerbel Sinha, Alexander Laskin, *Purdue University*

The light-absorbing fraction of organic aerosols, commonly known as brown carbon (BrC), is a significant contributor to climate change. Biomass burning (BB) emissions of BrC are ubiquitous over Indo-Gangetic Plain (IGP). BB is very common in India because of biofuel usage for heating and cooking, agricultural residue burning, and uncontrolled garbage burning. Despite their abundance, the molecular-level understanding of BrC composition in IGP area is limited. Here, we investigate chemical composition of BrC collected at a suburban site in the northwest IGP. The aerosol samples were collected at the Atmospheric Chemistry facility (30.667° N−76.729° E, 310 m above sea level) of the IISER, Mohali. Compositional information was obtained by employing ambient ionization with high-resolution mass spectrometry. Specifically, Direct Analysis in Real Time High Resolution Mass Spectroscopy (DART-HRMS) was used to analyze samples of organic aerosols collected on the filter spots of 7-wavelength aethalometer. The samples were collected in two different seasons – post-monsoon, and winter. Post-monsoon season is dominated by largescale paddy residue burning whereas winter season is dominated by biofuel (wood and dungcakes) burning for heating and cooking purposes. Comparative analysis of optical records from the aethalometer and molecular information from DART-HRMS was used to assess the relationship between the chemical composition and optical properties of BrC.

9RA.8

Comparison of Fine Particulate Nitrate Formation in the Presence of Excess Ammonia at Livestock and Crop Agricultural Sites in Summer. JOONWOO KIM, Jiho Jang, Dahye Oh, Haebum Lee, Taewoong Gong, Kihong Park, *Gwangju Institute of Science and Technology*

Fine particulate nitrate formation often leads to severe haze pollution in winter when the particle phase is favored in reversible phase equilibrium with precursor gases (e.g., ammonia (NH_3) and nitric acid (HNO_3)) at low temperature. Summertime nitrate formation is relatively unlikely to occur because of high evaporation, but may be altered by excess ammonia. To explore the formation of nitrate in the presence of excess ammonia in summer, we performed intensive field measurements of fine particles and gases at two distinct ammonia-rich agricultural sites (livestock and crop agricultural sites) in Gimje, Korea during the summers of 2020 and 2021. The ISORROPIA II thermodynamic equilibrium model was applied to estimate aerosol pH, aerosol water content, and gas/particle partitioning ratios. The average ammonia concentrations were 81.7±84.3 ppb at the livestock agricultural site and 20.8±14.9 ppb at the crop agricultural site, elevating aerosol pH (3.9±0.3 and 3.4±0.3, respectively). The average mass fraction of nitrate in $PM_{2.5}$ was higher at the livestock agricultural site (21.9%) than at the crop agricultural site (19.2%) with higher nitrate partitioning ratios ($[NO_3^-]/([HNO_3]+[NO_3^-])$; 0.91±0.11 and 0.69±0.24, respectively). The nitrate oxidation ratios ($[NO_3^-]/([NO_2]+[NO_3^-])$) were more correlated with aerosol water content than O_3 concentration, indicating that aqueous reactions at night were important. Secondary inorganic aerosol concentration, aerosol water content, and nitrate partitioning ratios increased collectively, resulting in haze pollution. Our results clearly show that excess ammonia contributes to summertime nitrate formation.

9RA.10

Chemical Characterization of Brown Carbon in Atmosphere and Snowpack from the Rocky Mountains. STEVEN SHARPE, Felipe Rivera-Adorno, Jay Tomlin, Erik Hulm, Ryan Moffet, Alexander Laskin, *Purdue University*

Snow fall is a crucial source of fresh water, nutrients, and carbon for land ecosystems, especially in mountain regions. Deposits of atmospheric aerosols within snowpack are high photochemically active, which influences the local land-atmosphere interactions. In terms of climate effects, snowpack is one of the highest light reflecting surfaces on Earth, and a key factor in Earth’s radiative balance. The deposition of light-absorbing particles composed of brown carbon (BrC), black carbon (BC), and mineral dust significantly impacts the absorption of solar radiation. This results in decreased snow albedo and accelerates the rate of snow melt, which in tern influences the regional and global climate. Our study uses microscopy, optical measurements, and molecular characterization to investigate the radiative properties of carbonaceous aerosols in regard to snow albedo, assess the relationships between composition of airborne BrC and that deposited on the snowpack. The study incorporates real time aerosol sampling and monitoring at a Colorado field site using an aethalometer coupled with a CO_2 probe. Particle and snow samples are collected for bulk composition analysis utilizing chemical imaging and molecular characterization techniques. These analyses will be able to differentiate between anthropogenically and naturally generated carbonaceous aerosols and how they impact Colorado alpine snowpack. We have found that the majority of light absorption comes from BrC with only minor absorption from BC and mineral dust.

9RA.11

Quantifying Aerosol Diversity of an Arctic Oil Field on a Single Particle Level. JUDY WU, Jun Liu, Matthew Gunsch, Jessica Mirrielees, Claire Moffett, Rebecca J. Sheesley, Qi Zhang, Swarup China, Kerri Pratt, *University of Michigan*

As the Arctic rapidly warms, sea ice extent is decreasing, and oil and gas extraction are increasing. The emissions from these processes affect the distribution of chemical species across individual particles within an aerosol population, or chemical mixing state, which impacts properties such as reactivity and hygroscopicity, with implications for air quality and human health. In August – September 2016, the sources, chemical composition, and mixing states of atmospheric aerosols within an Arctic oil field (Oliktok Point, Alaska) were investigated using a suite of instrumentation. An aerosol time-of-flight mass spectrometer measured the real-time size and chemical composition of single particles. Aerosol particles measured in this study mainly included diesel soot, amine-containing organic sulfate particles, aged combustion aerosol, and sea spray aerosol; these particles were frequently internally mixed with sulfate and nitrate, indicative of secondary aerosol production within the oil field. Bulk mass concentrations of submicron non-refractory species were measured by a time-of-flight aerosol chemical speciation monitor, and black carbon was measured by an aethalometer. Additionally, scanning electron microscopy with energy-dispersive x-ray spectroscopy measured elemental ratios for the sea spray and mineral dust particles. Using a combination of the techniques mentioned above, we can quantify the contributions of these single-particle types and the overall diversity of PM_1 (particulate matter < 1 µm in diameter) to determine the mixing state index χ, a parameter representing how internally or externally mixed a particle population is at a given time, over the course of the field campaign. Here, we present the aerosol mixing state within oil field plumes, compared to background air, by examining the main aerosol species (sulfate, nitrate, ammonium, organic carbon, black/elemental carbon, chloride, sodium) over time. Accurate representation of atmospheric aerosol mixing state is important for air quality and climate modeling, which typically uses an internal mixing assumption.

9RA.12

Impacts of Automated Isoprene Chemical Mechanism Reduction on SOA Chemistry and Air Quality in GEOS-Chem. BENJAMIN YANG, Forwood Wiser, V. Faye McNeill, Arlene Fiore, Daniel Westervelt, *Columbia University*

Biogenic volatile organic compounds, chiefly isoprene, are a significant source of secondary organic aerosols (SOA) and other air pollutants in the eastern U.S. during summer. The chemical mechanism is highly complex, thus difficult to manually update and often the most computationally-intensive component of global 3-D chemical transport models including GEOS-Chem. Employing our novel, graph theory-based Atmospheric Chemistry Model Reduction (AMORE) algorithm, we condense the full-chemistry GEOS-Chem mechanism involving gas-phase isoprene oxidation by 33 species (-11%) and 161 reactions (-18%). Sensitivity simulations in which isoprene emissions are artificially removed in the model are compared to a base case with both the AMORE and default mechanisms at 2° x 2.5° horizontal resolution in order to quantify changes in ozone, SOA, fine particulate matter ($PM_{2.5}$), nitrogen oxides, among others. Specifically, U.S. and global biogenic isoprene emissions are each set to zero in order to determine their fractional contributions to air pollution via both mechanisms. We utilize ground-based, airborne, and sonde measurements, such as from the Long Island Sound Tropospheric Ozone Study (LISTOS) campaign, to evaluate our base case AMORE and default GEOS-Chem mechanism simulations. Initial tests reveal that the wall time of a one-month GEOS-Chem classic simulation run on 32 cores on a single node is reduced by 1-2 hours (from 17-18 hours to 16-17 hours), while AMORE estimates slightly higher annual surface $PM_{2.5}$ by 0.2 $\mu g\ m^{-3}$ and ozone by 1.9 ppb on average in the eastern U.S. relative to the default mechanism. We aim to make AMORE open source and sufficiently flexible to allow for timely future updates and application to other chemical systems (e.g. aqueous-phase) for efficient air quality forecasting, research, and management.

9RA.13

SAIL-NET: Investigating Spatial Variability of Aerosol and Cloud Nuclei in Mountainous Terrain. Anna Hodshire, EZRA LEVIN, Gavin McMeeking, Bryan Rainwater, Ethan Emerson, Nicholas Good, Kate Patterson, Tom Ramin, *Handix Scientific*

Atmospheric aerosols can have large impacts on clouds and precipitation by serving as cloud condensation nuclei (CCN) and ice nucleating particles (INP). Understanding the impacts of these particles on clouds is critical to improving our understanding of and ability to forecast precipitation and its resulting impacts on the hydrologic cycle. This predictive ability is especially important in the western United States, and other regions globally, where mountain-impacted precipitation is critical to local and downstream water supplies. To better understand aerosol-cloud interactions in mountain regions, we deploy a novel network of miniaturized instrumentation in the East River Watershed near Crested Butte, Colorado, U.S. in the vicinity of the U.S. Department of Energy (DOE)-funded Surface Atmosphere Integrated Field Laboratory (SAIL). SAIL instrumentation includes an ARM Mobile Facility (AMF2) and the Aerosol Observing System (AOS), which have an extensive suite of aerosol, cloud, and meteorological measurements. These measurements are confined to a limited spatial domain which could miss important regions of aerosol-cloud interactions, especially in complex topography. To expand the SAIL aerosol measurements, we have deployed SAIL-NET, a network of six aerosol measurement nodes spanning both the horizontal and vertical extent of the SAIL domain. Each microphysics measurement node includes a small optical particle counter (POPS) which provides particle number and size between 140 nm - 2 um; a novel, miniature cloud condensation nuclei counter (CloudPuck); and a filter sampler (IcePuck) for subsequent ice nucleating particle analysis. SAIL is scheduled to run between September 2021-June 2023, and SAIL-NET will collect measurements for the majority of that time. We discuss challenges associated with setting up completely self-sufficient remote sites and results on how aerosol concentrations vary both spatially and temporally. Interesting features include remarkably spatially consistent aerosol concentrations in the fall of 2021, with more interesting changes appearing with winter-spring of 2021-2022.

10AC.1

Organosulfate Formation in Proxies for Aged Sea Spray Aerosol: Reactive Uptake of Isoprene Epoxydiols to Acidic Sodium Sulfate.

MADELINE COOKE, Ziying Lei, Yuzhi Chen, N. Cazimir Armstrong, Yue Zhang, Nicolas Aliaga Buchenau, Isabel Ledsky, Jamy Lee, Avram Gold, Zhenfa Zhang, Jason Surratt, Andrew Ault, *University of Michigan*

Oxidation of isoprene, the biogenic volatile organic compound with the highest emissions globally, is a large source of secondary organic aerosol (SOA) in the atmosphere. Organosulfates, particularly methyltetrol sulfates, formed from acid-driven reactions of isoprene epoxydiols (IEPOX), a key oxidation product, are important contributors to SOA mass. To date, most studies have focused on organosulfate formation on ammonium sulfate particles at low pH. However, recent work has shown sea spray aerosol (SSA) in the accumulation mode (~100 nm) is often quite acidic (pH ~ 2) and IEPOX-derived organosulfates have been identified in marine environments. Herein, we demonstrate that substantial SOA, including organosulfates, are formed on acidic sodium sulfate particles (pH = 1.3), representative of marine aerosol heterogeneously reacting with H2SO4 to form Na2SO4. For acidic sodium and ammonium sulfate particles, 31 and 28% (±1%), respectively, of inorganic sulfate is incorporated into organosulfate species, even though acidic particles with sodium versus ammonium as the primary cation formed 5% (±0.2) less SOA volume and 45% (±6%) less methyltetrol sulfates, suggesting other organosulfates may form. Even though both exhibited core-shell morphology after IEPOX uptake, physicochemical differences were observed via Raman microspectroscopy, with organosulfates identified in both the core and shell of acidic ammonium sulfate SOA particles, but only in the core for acidic sodium sulfate SOA via Raman microspectroscopy. Our results suggest that isoprene-derived SOA formed on aged SSA is potentially an important, but underappreciated, source of SOA and organosulfates in marine and coastal regions and could modify SOA budgets in these environments.

10AC.2

Characterization of S(IV) Species and Sulfate in PM2.5 in Fairbanks, Alaska using Ion Chromatography.

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

Fairbanks, Alaska is an arctic city that is severely polluted during the winter with notably high concentrations of atmospheric particulate matter ($PM_{2.5}$). Sulfate (SO_4^{2-}) and S(IV) species have been identified as a significant component of $PM_{2.5}$ (about 20%), but their chemistry is still not well-understood under typical local conditions of extreme cold and low concentrations of oxidants such as O_3. Hydroxymethanesulfonate (HMS) is an adduct of formaldehyde (HCHO) and the precursors sulfite (SO_3^{2-}) and bisulfite (HSO_3^-), and it was recently identified in heavy pollution events elsewhere. As part of the Alaska Pollution and Chemical Analysis (ALPACA) Campaign that took place in January-February of 2022, we deployed several instruments to Fairbanks to obtain both online and offline measurements of sulfur-containing species. The Particle-Into-Liquid-Sampler (PILS) system coupled to ion chromatography was used to obtain 20-minute continuous measurements of sulfate and total S(IV). $PM_{2.5}$ filters were collected daily, and these were extracted and analyzed offline with ion chromatography. These data show that total S(IV) levels are enhanced at high levels of sulfate and low temperatures, and the fraction increases with increasing levels of sulfate during pollution events. Additional experiments were performed on filter extractions to determine the partitioning of HMS, bisulfite, and sulfite. Preliminary data suggests that about 68% of the $PM_{2.5}$ S(IV) measured in Fairbanks during this time is HMS, and that HMS scales linearly with total S(IV). This work is one part of a greater collaborative effort to better characterize low-temperature atmospheric sulfur chemistry and the chemistry within supercooled aerosol droplets, as well as improve current models to reflect an updated understanding of reaction mechanisms and aerosol phenomena.

10AC.3

HMS/Sulfate Ratio as a Constraint on Aqueous Sulfur Chemistry Under Cold and Dark Conditions.

JAMES CAMPBELL, Michael Battaglia, Kayane Dingilian, Jason St. Clair, Meeta Cesler-Maloney, William Simpson, Athanasios Nenes, Rodney J. Weber, Jingqiu Mao, *University of Alaska Fairbanks*

Fairbanks, Alaska is a subarctic city with fine-particle (PM2.5) concentrations that often exceed air quality regulations in winter due to weak dispersion caused by strong atmospheric inversions, local emissions, and the unique chemistry occurring under cold and dark conditions. Sulfate accounts for roughly 20% of PM2.5 mass in wintertime Fairbanks. Hydroxymethanesulfonate (HMS) is comparable to PM2.5 sulfate (HMS/sulfate molar ratio of 26-41%), and comprises a significant fraction of overall PM2.5 mass concentration (2.8-6.8% by mass) during polluted episodes. This high relative fraction of HMS is substantially higher than observed elsewhere, likely due to low temperatures and high levels of precursors. Here, we developed a box model that couples aerosol thermodynamics (using the ISORROPIA-II model) that explicitly calculates the liquid water uptake, inorganic speciation and acidity with aerosol aqueous chemistry (F0AM-aq) to study the secondary production of sulfate and HMS in Fairbanks winter. We find that both HMS and sulfate production are self-limiting owing to the rapid change of aerosol acidity as a result of sulfate production. While uncertainties exist in the aerosol pH, ionic strength, aqueous diffusion and chemistry, we find that the HMS/sulfate ratio depends primarily on the branching ratio of several sulfur (IV) reaction pathways, providing a unique constraint on aqueous sulfur chemistry under cold and dark conditions. Subsequent work will focus on the role of HMS and organic species on ALWC and its impact on acidity and aqueous chemistry, by replacing ISORROPIA-II with its most recent version (ISORROPIA-Lite) that can consider such interactions.

10AC.4

Role of Methane Sulfonic Acid in Sulfuric Acid-Base Nucleation.

JACK JOHNSON, Coty Jen, *Carnegie Mellon University*

Aerosol nucleation accounts for over half of all seed particles for cloud droplets. In the atmosphere, sulfuric acid (SA) nucleates with ammonia, amines, oxidized organics, and many more compounds to form particles. Studies have shown that methane sulfonic acid (MSA) also contributes to particle formation in the atmosphere. While MSA has been shown to nucleate particles with amines and ammonia, there is still limited knowledge on how MSA and SA nucleate together in the presence of various basic compounds. In this work, we show that SA and MSA react to form particles with ammonia, methylamine, dimethylamine, trimethylamine. Measurements indicate that the formation of the heterodimer of SA and MSA is a significant step in the formation of a particle. These results indicate that to accurately predict particle nucleation rates in the atmosphere, it will be necessary to account of kinetic interactions between SA, MSA, and various amines.

10AC.5

Isoprene Epoxydiol-Derived Sulfated and Non-Sulfated Oligomers Suppress Particulate Mass Loss during Oxidative Aging of Secondary Organic Aerosol. N. CAZIMIR ARMSTRONG, Yuzhi Chen, Tianqu Cui, Yue Zhang, Zhenfa Zhang, Barbara Turpin, Man Nin Chan, Avram Gold, Andrew Ault, Jason Surratt, *UNC-Chapel Hill*

Acid-driven multiphase chemistry of isoprene epoxydiols (IEPOX) with inorganic sulfate aerosols contributes substantially to formation of secondary organic aerosol (SOA), which constitutes a large mass fraction of atmospheric fine particulate matter ($PM_{2.5}$). However, atmospheric chemical sinks of freshly generated IEPOX-SOA particles remain unclear. We examined the role of heterogeneous oxidation of freshly-generated IEPOX-SOA particles by gas-phase hydroxyl radical (•OH) under dark conditions as one potential atmospheric sink. After 4 h of gas-phase •OH exposure (~$3x10^8$ molecules cm^{-3}), chemical changes in smog chamber-generated IEPOX-SOA particles were assessed by hydrophilic interaction liquid chromatography coupled with electrospray ionization high-resolution quadrupole time-of-flight mass spectrometry (HILIC/ESI-HR-QTOFMS). Comparison of molecular-level compositional changes in IEPOX-SOA particles during aging with or without •OH revealed that decomposition of oligomers by heterogeneous •OH oxidation acts as a sink for •OH and maintains a reservoir of low-volatility compounds including monomeric sulfate esters and oligomer fragments. We propose tentative structures and formation mechanisms for previously uncharacterized SOA constituents in $PM_{2.5}$. Our results suggest that this •OH-driven renewal of low-volatility products may extend atmospheric lifetimes of IEPOX-SOA particles by slowing production of low-molecular weight, high-volatility organic fragments, and likely contributes to large quantities of 2-methyltetrols and methyltetrol sulfates reported in $PM_{2.5}$.

10AC.6

The Potential Environmental and Climate Impacts of Stratospheric Aerosol Injection: A Review. HAN N. HUYNH, V. Faye McNeill, *Columbia University*

Given the rise in global mean temperature as a direct consequence of increasing levels of greenhouse gases (GHG) in the atmosphere, a variety of climate engineering approaches, including stratospheric aerosol injection (SAI), have been proposed. Often criticized as a distraction from global efforts towards reducing GHG emissions, SAI aims to increase the Earth's albedo by seeding aerosols in the lower stratosphere. SAI has been explored extensively in modeling studies following observations of temporary cooling of the Earth's surface following major volcanic eruptions which introduced significant loadings of sulfate particles into the stratosphere. The cooling effect is accompanied by other significant consequences including stratospheric heating, stratospheric ozone (O3) depletion, and reduced global mean precipitation. In order to understand the potential environmental and climate impacts of SAI, we review the state of the knowledge regarding these issues, starting from an aerosol science perspective. We summarize aerosol radiative properties and the role they play in defining the optimal chemical and physical aerosol characteristics for SAI, and their implications for lower stratospheric warming. We then review in depth the impacts of stratospheric aerosol heterogeneous chemistry on global O3 levels. We review SAI modeling studies as well as their uncertainties, in comparison to the observed environmental and climate impacts of volcanically derived sulfate aerosols, including impacts on global temperature, stratospheric warming, and hydrological cycle. We also discuss the current governance and economic considerations of the application of SAI and raise essential questions from both research and social standpoints that must be addressed before SAI is deployed for climate change mitigation.

10AP.1

Ice Nucleation Activity and Effloresced Particle Morphology of Model Marine Aerosol Systems in a Microfluidic Device.

MARGARET HOUSE, Cari Dutcher, *University of Minnesota*

Atmospheric aerosol particles effect on climate and human health has been studied since the 19th century, and yet many aspects of their impacts are still unknown. Both composition and physical phase of an aqueous atmospheric aerosol particle are important in determining its role in climate. The ice nucleation (IN) activity and the role of biological particles biological particles like bacteria and bacterial fragments within aqueous aerosol particles as ice nucleating particles (INP) is of great interest to atmospheric and climate studies, due to the ability of INP type to change the resultant optical properties of clouds. Microfluidic methods have recently emerged in the field of atmospheric aerosol science as a companion to other single particle methods for measuring phase-change behavior as well as IN activity. Such techniques, which utilize flow-through or static droplets in microfluidic channels, can have a number of key advantages in the observation of some physiochemical phenomena. Microfluidic channels can be used to readily study both evaporative phase transitions and freezing behavior on a single droplet level. In this study, the freezing behavior and final effloresced particle morphology of model marine aerosol solutions is studied in microfluidic devices for the purpose of linking composition, crystal morphology, and IN activity.

10AP.2

Color Imaging of Aerosol Particles with Backscatter Multiple Wavelength Digital Holography.

RAMESH GIRI, Matthew J Berg, *Kansas State University*

Course mode aerosol particles with sizes greater than 1 um are common in nature and contribute to various atmospheric changes. To better understand the impact of aerosols on the local and global climate, as well as the global radiation budget, it is critical to understand the way these particles interact with light of various wavelengths. Generally, materials of different composition interact differently across the visible spectrum, yet in situ observations of the material composition of aerosol particles is limited. In previous work, we observe the color images of opaque microparticles fixed to a glass window using backscatter multiple wavelength digital holography [1]. This is extended in this work, to produce color images of aerosol particles without trapping or collecting the particles. A chromaticity analysis is then applied to assess whether particles with different material compositions can be differentiated based on their images' color content.

References:

[1] R. Giri and M. Berg, "Backscatter multiple wavelength digital holography for color micro-particle imaging," Appl. Opt. 61, B83-B95 (2022).

10AP.3

Looking Back and Forward – from the Environmental Chamber to Particle Loss Correction. CHEN LE, Qi Li, Ningjin Xu, Huawei Li, Don Collins, David Cocker, *University of California, Riverside*

Minimizing uncertainty from particle- and vapor-loss corrections are critical for accurately quantifying aerosol yield from environmental chambers. Particle wall-loss behaviors in the UCR previous-generation dual 90-m^3 collapsible chambers were dominated by electrostatic deposition and the percentage of particle wall-loss correction versus measurable mass yield was significant. For this previous set-up, the loss of particle and vapor molecules driven by the chamber surface static charge significantly interrupted the investigation of vapor wall-loss effects, especially for low SOA-formation experiments which were widely applied in vapor wall-loss characterization studies. A new-generation 120-m^3 fixed-volume indoor chamber has been constructed at UCR and it has been experimentally observed to have minimal electrostatic-driven particle wall-loss. However, with ~90% of the traditional particle wall-loss reduced, particle coagulation dynamics are no longer negligible, affecting the traditional number concentration-based particle wall-loss correction method; other previously under-represented loss processes, such as chamber dilution and vapor wall-loss become more significant. A systematic evaluation of coagulation, dilution and vapor wall-loss effects on historical and future experimental data was thus desired.

In this work, 1) the significance of particle coagulation on the traditional number-averaged correction method are re-visited for thousands of historical runs, indicating an averaged 25% over-correction of wall losses from the traditional method in nucleation experiments and up to 50% over-correction of wall losses in seeded experiments; 2) particle wall-loss processes are re-characterized for the new 120-m^3 chamber based on size-dependent mono-dispersed characterization experiments with observed losses more sensitive to particle size approaching reported patterns for other chambers with minimum electrostatic effects; 3) chamber dilution effects on particle concentration decay was evaluated using a tracer compound (perfluorohexane) in experiments and such loss becomes observable given the major reduction on particle wall-loss; 4) a new standard three-component correction process of particle-loss has been proposed and verified; 5) vapor wall-loss have been investigated by a series of seeded m-xylene oxidation experiments, implying observable SOA mass yield correction compared to the previous-generation chambers.

10AP.4

Geometric Model for Predicting the Morphology Evolution of a Multiparticle Agglomerate during Simultaneous Reaction and Sintering. SUJIT MODI, Onochie Okonkwo, Hao Zhou, Shalinee Kavadiya, Marcus Foston, Pratim Biswas, *Washington University in St Louis*

The size and surface area of nanosized agglomerates play a crucial role in determining their performance in healthcare, energy storage, and catalysis [1]. Sintering rate, which governs the agglomerate size and the morphology, is traditionally obtained using mobility size techniques [2]. However, for materials that undergo decomposition reactions at sintering temperature the effect of the reaction on the observed mobility size change must be accounted for accurate estimation of sintering rates. To the best of our knowledge, existing modeling studies of sintering haven't accounted for the simultaneous reactions. Thus, the sintering rate of a range of materials such as biomaterials including lignin and chitosan remains undetermined. In this study, we developed a novel geometric model (GM) to predict the evolution of size and morphology under simultaneous sintering and reaction. The model focus is on estimating sintering preexponential factor and activation energy, which are required to predict the evolution in size and morphology with time and temperature. Additionally, to demonstrate the application of developed GM, an alkali type lignin is used as a model compound and its preexponential factor and activation energy were estimated to be 6.6×10^{-8} s. nm^{-1} and 116.4 kJ $(K.\ mol)^{-1}$ respectively. Predictions of size and morphology using estimated values agreed with independent experimental measurements. This study provides first-time key insights into sintering rates of the lignin and provides operational guidelines for minimal aggregation and smooth operation in its continuous pyrolysis reactors. The developed GM is generalized and can also be applied to study other materials.

[1] Martins et al., Journal of Geophysical Research: Atmospheres 103, 32041-32050, 1998
[2] Cho et al., Aerosol science and technology 40, 309-319, 2006

10AP.5

Estimation of Effective Density and Fractal Dimension of Secondarily Produced Brown Carbon Particles.

ALEXANDER B. MACDONALD, Nilofar Raeofy, Kunpeng Chen, Haofei Zhang, Ying-Hsuan Lin, Roya Bahreini, *University of California, Riverside*

Brown carbon (BrC) aerosols are light-absorbing organic particles that have a potentially large but uncertain impact on Earth's radiative forcing. Examining BrC morphology (size and shape) and density will help reduce this uncertainty since these parameters are important in calculating aerosol radiative and transport properties. Primary BrC particles are emitted by biomass burnings and secondary BrC particles are produced via oxidation reactions of precursor volatile organic compounds (VOCs). Primary BrC particles are reported to have a fractal-like branched structure. This study examines how the VOC precursor influences secondary BrC particle density and morphology. BrC aerosols are generated in an environmental chamber from nitrate radical oxidation of three different heterocyclic VOCs (furan, pyrrole, and thiophene) under different NOx conditions. An Aerodyne mini aerosol mass spectrometer (mAMS) and a Brechtel scanning electron mobility sizer (SEMS) are used to measure size-resolved distributions of mass concentration and number concentration, respectively. Transmission electron microscopy (TEM) is used to obtain magnified images of aerosol samples from a subset of the experiments. Effective particle density (ρeff) is derived using the mAMS's vacuum aerodynamic diameter (Dva) and the SEMS's electrical mobility diameter (Dm). Particle morphology is approximated with the fractal dimension (Df), a mathematical parameter that describes the non-spherical branched structure of a particle. Df is approximated by applying the self-preserving size distribution theory to SEMS size distribution data when agglomeration is the dominant mechanism driving particle growth. Our findings suggest that BrC aerosols with a fractal-liked structure are formed in some systems due to the agglomeration of significantly smaller primary particles (spherules) and that the size distribution of these fractal-like aerosols is adequately described using the self-preserving size distribution theory. The ρeff and Df appear to be influenced by the VOC precursor.

10AP.6

Aerosol Deposition in 90-Degree Circular Tube Bends with Laminar Flows: Effects of Inertial Impaction and Gravitational Settling.

JAMES Q. FENG, *Optomec, Inc.*

As studied by many authors, the behavior of particles in aerosol flow through bent tubes is relevant to a variety of technological developments for practical applications. The present work is no exception, motivated by the need of understanding ink droplet loss during mist transport in Aerosol Jet® printing. While majority of works in the literature have considered particle deposition in tube bends with the tube flow Reynolds number Re > 1000, the mist flow in transport channels of Aerosol Jet® printer often has Re < 100. Here, the effects of inertial impaction and gravitational settling with laminar flows in 90-degree bends are examined using an OpenFOAM® CFD package, for Re ~ 50 to 1000. The computational code is verified by comparing with the experimental result of Pui et al. for Re = 1000. Besides inertial impaction due to the centrifugal forces in bends, the effect of gravitational settling is shown to become increasingly significant with reduction of tube flow velocity, which can also be quite sensitive to the bend orientation when mist flow rate is low. For situations of downward bend or upward inlet, where the gravitational force and centrifugal force are opposing each other, the effect of gravitational settling appears relatively insignificant. However, the particle deposition efficiency is generally enhanced in upward bends or bends with downward inlet, where the gravitational force and centrifugal force are reinforcing each other, exhibiting large deviations from the zero-g case, especially at lower flow velocities (i.e., smaller Froude number).

10CM.1

Effects of Different Dust Suppression Approaches on Ambient Aerosols. JASON MIECH, Pierre Herckes, Matthew Fraser, *Arizona State University*

PM_{10} and $PM_{2.5}$ samples were collected from several plots of land treated with various dust suppression methods, including enzyme-induced calcium precipitation, magnesium chloride, and microbe-induced calcium precipitation. Samples were collected from the plots during excitation of dust accomplished by driving a truck over the plot multiple times with and without a chain-link fence dragged behind it. Chemical analyses on the samples included ion chromatography and inductively coupled plasma mass spectrometry to identify components of the treatments that became entrained. In addition to obtaining PM_{10} and $PM_{2.5}$ concentrations from the aerosol samples, a DustTrak™ DRX Aerosol Monitor 8533 was also used to monitor the PM_{10} concentration in real-time. These results will be used to evaluate the air quality impact of these dust suppression methods in addition to their effectiveness.

10CM.2

Spray Droplet Size in Liquid Sheets Containing Surfactants and Oil Emulsions. IAROSLAV MAKHNENKO, Long Nguyen, Cari Dutcher, Christopher J. Hogan, Elizabeth Alonzi, Christine Colby, Steven Fredericks, *University of Minnesota*

Droplet atomization is a common process in everyday life with applications in agriculture, drug administration, printing, and painting. For agriculture purposes, small droplets generated from liquid sheets are needed to enhance coverage of agricultural sprays, but not so small that they cause drift of the sprayed pesticides. Spray drift can cause the deposition of chemicals to undesired areas with a negative impact on livestock, ecosystems, and human health. In this work, different factors influencing spray break-up and droplet size distributions are discussed. Herein we experimentally measure the droplet size distribution of sprays from agricultural spray nozzles containing surfactants and oil emulsions using a wind tunnel. We identified the influence on spray volume fraction below 150 µm and on the volume median diameter, which are correlated with the spray drift risk and deposition, respectively. In addition to the wind tunnel experiments, we study uptake and penetration of spray chemicals on the surface of a leaf. It includes measurements with varied humidity to study the phase state of a droplet under different conditions, and fluorescent microscopy to observe the uptake and spreading of a droplet. The results of this work will help to understand the factors affecting a droplet size during a spraying process, towards increased efficacy of spraying pesticides.

10CM.3

Suppressing Spread of Viral Sneeze Droplets Using Transparent Curtains in Large Food Processing Facilities.

SUNIL KUMAR, Maria King, David Klassen, *Texas A&M University*

The COVID-19 pandemic disrupted the world health system infrastructure. The fast spread of the virus compelled countries to impose lockdown, restrict movement of people, limit the industrial production, supply chains to control the spread of the coronavirus. However, spread of virus caused large population to admit in hospitals requiring moderate to intensive care. The contagious virus was found to be spreading mainly through air compared to other prominent mode of surface deposition. The transport of virus through air specially in indoor environment depends upon the air flow patterns developed in the presence of diffuser and exhaust. The facilities with large number of occupants such as assembly rooms, packaging room, and fabrication room of meat facilities, remain at critically high risk in a conventional Heating, Ventilation, and Air Conditioning (HVAC) setup. The air streams generated from ventilation ports are complex and long, which can transport the virus from one corner of the food processing plant to another corner. In a closed environment of this kind, a single sneeze from an asymptomatic worker can potentially spread the virus droplets to the whole facility and turn it to be a super spreader for community. A safer indoor facility requires effective prevention and removal of contaminated droplets. Therefore, necessary design modifications of air flow patterns are needed to control the spread of virus. The research work presented in this paper evaluates effect of installation of transparent partition between workers. The installation of partitions cutoff the long-range air streamlines capable of transporting virus from one location to another. The partitions prevent spread of virus loaded droplets in local environment of the potential spreader. Study optimizes design of partitions to maximize the containment of droplets. The study is applicable in every industry irrespective of its size and type of work.

10CM.4

Aerosol Dispersion of Submicrometer Particles in an Aircraft Cabin.

Stephanie Vannarath, Peter Kim, Mitchell Ford, Arvind Santhanakrishnan, Yu Feng, CHANGJIE CAI, *The University of Oklahoma Health Sciences Center*

In 2020, air travel experienced a sharp and unprecedented decline by more than 50% compared to 2019, totaling $500 billion or 0.5% global GDP in losses due to the Coronavirus Disease 2019 (COVID-19) pandemic, which is caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Airborne transmission is a concern in densely populated areas and highly confined indoor environments such as airline cabins. Airlines have implemented strategies to increase proximity to make up for this disruption. However, submicrometer particles could remain in the air longer and travel further compared to large droplets. The overall goal of this study is to analyze aerosol dispersions in the aircraft cabin while the aircraft is running, and propose potential control methods. Therefore, three specific aims were developed to achieve the goal. Aim 1 evaluates the effectiveness of MD-80 (Boeing 717 precursor) aircraft ventilation on reducing particles by size. Aim 2 characterizes the spatial distributions of the submicrometer particles by size under various scenarios (e.g., with and without ventilation, with and without fan gaspers, etc.). Aim 3 evaluates the effects of gasper fan utilization, distance from the aerosol generator source, and seating direction from the aerosol generation source on particle concentrations in the aircraft cabin. The results show that ventilation significantly reduces ~0.1 – 0.4 µm particles present in the aircraft cabin. Gasper utilization is an effective method of reducing all submicrometer (~0.1 – 1.0 µm) particles. The General Linear Modeling determines that gasper utilization, distance from the aerosol generator, and seating position to the aerosol generator have significant effects on particle concentration in the MD-80 aircraft.

10CM.5

Improvement of Air Quality in Vehicles – Simulation of Two Different Use Cases of HEPA Filtration. Matisse Lesage, David Chalet, Jérôme Migaud, Christoph Krautner, SHIKHAR ARORA, Nilesh Tharval, Martin Lehmann, *MANN+HUMMEL GmbH*

The air quality inside a vehicle is of high interest for the health of humans, particularly for professionals like bus, taxi and truck drivers who spend most of their time on the road. Vehicles operate in rough environments or urban locations with high fine dust concentration. Drivers and vehicle occupants can be exposed to high level of pollution.

The proposed solution to improve the air quality in the vehicle is the Smart Cabin Air Filter system. It introduces a HEPA (High Efficiency Particulate Air) filter in the fresh air path, protected by a pre-filter, in addition to the traditional interior filter in the air conditioning unit. The study focuses on optimizing filter life time. The effect of this smart and sensor driven three-filter system on total energy consumption and driving range will also be part of upcoming studies.

The HEPA filter uses a high-end filtration technology coming from the clean room industry, which plays a major role to limit the concentration of ultra-fine particles in the cabin. In order to maintain its performance at a high level while limiting maintenance costs, its lifespan must be maximised. A system simulation tool is used to compare configurations on elaborated scenarios. The model used is calibrated with experimental data.

Two scenarios will be presented. One is preserving the HEPA filter by using the recirculation mode in the cabin as much as possible. A second scenario is bypassing the HEPA filter when it is not needed to improve air quality, thus reducing the usage of the HEPA element. With this control, the HEPA filter is used only when the fine particle concentration gets too high in the cabin. The simulation results show that this strategy is helpful: the savings are estimated at 60% in terms of usage time, and 48% regarding the particle loading.

10CM.6

Particulate and Gaseous Emissions from Tier II and III Diesel Engines on Ocean-Going Vessels. THOMAS ECKEL, Ryan W. Drover, J. Wayne Miller, David R. Cocker III, *University of California, Riverside*

We report on a field campaign studying stack emissions from 2 different technology classes of Ocean-Going Vessel (OGV) diesel engines. The study includes baseline data-logging activity and emissions testing of the main engines, auxiliary engines, and boilers on one Tier 2 OGV and data-logging activity and emission testing of the main engines, auxiliary engines, and boilers on two new-build, LNG-ready OGVs with Tier 3, low-NOx, dual-fuel engines. Various load points were tested at steady state and during acceleration and deceleration phases at berth and mid voyage. Two fuels were tested across both technology groups, CA ECA fuel, and global fuel.

On-line instruments were deployed to sample the following criteria pollutants: NOx, CO, SOx, PM2.5, and PM10. CO2 and O2% were also measured in real time. Realtime PM sizing was characterized by SMPS and Dusttrak. PM composition is reported for elemental carbon, organic carbon, and metal ions on gravimetric filter media at various loads following EPA guidelines for sampling Toxic Inorganics. Gaseous species were sampled for VOC, Heavy Hazardous Air Pollutants (HAPS), and Light HAPS at various loads using methods defined in the EPA guidelines for sampling Toxic Organics. An independent fuel composition analysis is also reported. Commercial marine GPS units deployed during open sea voyages over the course of the campaign served as independent Geographic Information Systems (GIS). The data from the commercial GPS (speed, heading, and location) allowed for better load context for the activity data. Loads were measured from both fuel flow and from stack gas flow measurements.

10EI.1 (Invited)

Aerosolization of Toxins from Harmful Algal Blooms in Freshwater and Saltwater. HOSEIN FOROUTAN, Charbel Harb, Landon Bilyeu, Regina Hanlon, Shane Ross, David Schmale, *Virginia Tech*

Harmful algal blooms (HABs) have been observed across the globe in waterbodies ranging from large freshwater lakes, such as the Great Lakes, to smaller inland lakes and reservoirs, as well as marine coastal areas and estuaries. Spatiotemporal increases in the occurrence of HABs have been reported and associated with climate changes and nutrient over-enrichment. The main health concern around HABs is the production of cyanotoxins, which may be ingested or inhaled by human or animals. The latter exposure route, governed by the aerosolization of HABs from aquatic environments, is far less understood, and consequently a framework to forecast or quantify risks associated with airborne cyanotoxins is still lacking. Although the mechanism of aerosolization is similar to well-documented sea spray aerosols (SSAs), complexities arise from differences in physiochemical properties of freshwater and saltwater, as well as the heterogeneous presence of HABs in waterbodies. We studied the role of salinity, contrasting marine and freshwater environments, in modulating spray aerosols, and found preferential aerosolization of certain bacterial families as water salinity changes. Furthermore, through a series of laboratory experiments investigating the physics of aerosolization at the air-water interface, we highlighted mechanistic differences between spray aerosols from saltwater and freshwater. These experimental results informed a parameterization for emissions of spray aerosols generated from freshwater bodies; also know as lake spray aerosols (LSAs). Regional atmospheric simulations showed that LSA particles generated from the Great Lakes may be transported hundreds of kilometers inland. To address the heterogeneity issue, we developed a drone-based collection system to sample and characterize aerosols and cyanotoxins in water and air. The capability of the system was demonstrated in a number of field studies. Altogether, these efforts help better quantify, predict, and potentially mitigate risks associated with aerosolized HABs.

10EI.2

Emissions of Harmful Algal Bloom Toxins in Freshwater Aerosol. NICOLE OLSON, Nathaniel May, Madeline Cooke, Jia Shi, Johnna Birbeck, Judy Westrick, Andrew Ault, Kerri Pratt, *University of Michigan*

Harmful algal blooms (HABs) caused by cyanobacteria produce toxins (e.g., microcystin) that are harmful to human and animal health. HAB intensity and frequency are increasing across the Great Lakes and globally, raising many questions about routes of exposure to algal toxins and impacts on human health. Aerosolization of HAB toxins in marine environments by wave breaking and recreational activities has been recently studied as an inhalation route of exposure for humans but has not been thoroughly studied for freshwater environments. In these studies, lake spray aerosols (LSA) were generated in the laboratory to mimic the wave breaking induced bubble bursting that occurs in open freshwater. LSA was made from ambient freshwater samples collected at various times during a HAB and with varying levels of biological activity. Microcystin toxins were identified in freshwater and laboratory-generated aerosol particles at atmospheric concentrations up to 50 ± 20 ng/m3. Enrichment of hydrophobic microcystin congeners (e.g., microcystin-LR) was observed in aerosol particles relative to bulk freshwater and was consistent with octanol-water partitioning coefficients for these compounds. As HABs are expected to increase with a warming climate, understanding and quantifying the emissions of algal toxins into the atmosphere is crucial for evaluating the potential health consequences of HABs.

10EI.3

Harmful Cyanobacterial Aerosolization Dynamics in the Airshed of a Eutrophic Estuary. HALEY E. PLAAS, Ryan Paerl, Karsten Baumann, Nathan S. Hall, Colleen Karl, Kimberly Popendorf, Malcolm A. Barnard, Naomi Chang, Nathaniel Curtis, Hwa Huang, Olivia Mathieson, Joel Sanchez, Daniela Maizel, Amy Bartenfelder, Jeremy Braddy, Karen Rossignol, Randolph Sloup, Hans W. Paerl, *UNC Chapel Hill*

In addition to obvious negative effects on water quality, recent work suggests that harmful cyanobacterial blooms (CHABs) impact air quality via emissions of cyanobacterial cells, cyanotoxins, and other emerging biogenic compounds. Several toxigenic cyanobacterial genera and cyanotoxins have been detected in aerosol, but the associated environmental controls and human exposure risks remain largely unknown. Accordingly, this study aimed to 1) investigate the occurrence of microcystin (MC) and cyanobacterial communities in $PM_{2.5}$, 2) elucidate environmental conditions promoting their aerosolization, and 3) evaluate other apparent associations between CHABs and regional air quality in the airshed of the Chowan River, a eutrophic estuarine system in eastern North Carolina impacted by recurring CHABs. In summer 2020, during peak CHAB season, continuous $PM_{2.5}$ samples and interval water samples were collected for targeted analyses of cyanobacterial community composition and MC concentrations. Supporting air and water quality measurements were made in parallel to contextualize findings and permit statistical analyses of environmental factors driving changes in key aerosol outcomes. Several aquatic CHAB genera which were genetically traced to water samples were identified in $PM_{2.5}$, including *Anabaena, Aphanizomenon, Dolichospermum, Microcystis, Pseudanabaena,* and *Tolypothrix*. Specific *Microcystis* populations exhibited higher relative aerosolization factors (r-AF) compared to other cyanobacteria, but this observation was not statistically significant due to high variability between sampling periods (average r-AF = 2.5 ± 4.07). MC production was low throughout the study, but a mixed assemblage CHAB dominated by *Dolichospermum* occurred from late-June to mid-July. In association with the CHAB, the median $PM_{2.5}$ mass concentration increased to 10.5 $\mu g\ m^{-3}$ (IQR = 4.55), significantly above the non-bloom background of 5.81 $\mu g\ m^{-3}$ (IQR = 5.48) (W = 1465, $p < 0.001$). Results underscore the need to better investigate the role that freshwater harmful algal blooms, specifically HABs, play in regional air quality and subsequent respiratory health risk.

10EI.4

Elucidating the Extent of Dust Aging at Miami and Barbados. HALEY ROYER, Michael Sheridan, Hope Elliott, Zihua Zhu, Andrew Ault, Nurun Nahar Lata, Zezhen Cheng, Swarup China, Cassandra Gaston, *University of Miami*

Reactions between dust particles and acids in the atmosphere (dust aging) can influence the radiative forcing of dust, cloud droplet formation, and biogeochemical cycles. In biogeochemical cycles, dust aging can enhance the often-poor solubility, and thus bioavailability, of essential nutrients like iron (Fe) and phosphorus (P) that can limit productivity, especially in oligotrophic waters like the tropical Atlantic. Dust aging also potentially increases carbon dioxide (CO_2) drawdown as the addition of bioavailable nutrients can enhance primary productivity. Though previous research shows that dust aging can take place, it isn't clear how prevalent this process is, particularly within the Saharan Air Layer (SAL) – the primary dust transport mechanism in the tropical Atlantic. In this work, we complement bulk aerosol chemical data from ion chromatography (IC) analysis with single-particle chemical techniques, including computer-controlled scanning electron microscopy with energy dispersive x-ray spectroscopy (CCSEM/EDX), single-particle aerosol mass spectrometry (SPAMS), and time-of-flight secondary ion mass spectrometry (TOF-SIMS) to elucidate the extent of aging at two dust receptor sites in the tropical Atlantic: Ragged Point, which is exposed to minimal anthropogenic influence, and Miami, which is influenced by high levels of anthropogenic activity. Results of bulk IC analysis show signs of aging as ions indicative of inorganic acids nitrate and sulfate, as well as organic acids like oxalate and formate, increase upon the arrival of dust to Barbados, suggesting aging may occur. However, CCSEM/EDX analysis reveals the presence of co-transported smoke particles with dust that may contribute to increased sulfate on dust particles. In Miami, signs of aging are present through high levels of nitrate found in bulk IC analysis and SPAMS analysis. These findings highlight the importance of using single-particle techniques for understanding the process of dust aging and provide insight into the extent of dust aging in the atmosphere.

10EI.5

On the Transatlantic Journey of Microorganisms Onboard Aeolian Dust Aerosols - A Statistical Analysis of Source, Destination, Routes, and Conditions along the Way. ALI HOSSEIN MARDI, Armin Sorooshian, Miguel Hilario, Hossein Dadashazar, Hosein Foroutan, *Virginia Tech*

Despite their proven role in the long-range transport of microorganisms, dust aerosols are lesser studied from this aspect. The goal of this research is to investigate the Aeolian dust aerosols, sourced from the Sahara and Sahel regions in northern Africa, and their ability to act as a medium to transport viable microorganisms across the Atlantic to westward regions located as far as the Amazon, the Caribbean and the southeast U.S. Specifically, we study the environmental conditions that dust aerosols experience in their transatlantic journey and their potential implications for survival of co-transported microorganisms. We tracked more than one hundred thousands of individual dust emission incidents via forward trajectory analysis from 2008 to 2021, across the Atlantic, focusing on the strongest dust emissions from northern African source regions during each season. At the downwind regions, we defined two receptor sub-domains and for each, we studied the seasonal trends observed in the number of dust trajectories, associated dust emissions, and ambient meteorological conditions along the trajectories. With our dataset, we investigated the cumulative impact of environmental parameters such as extreme temperature events, moisture content, and UV radiation, and their implications to the longevity and diversity of microorganisms being transported with dust particles.

10EI.6 (Invited)

Aerosolized Algal Toxins in South Florida, Health Impacts, and Exposure Mitigation Strategies. CASSANDRA GASTON, Kimberly Popendorf, Haley Royer, Raymond Leibensperger III, Michael Sheridan, Jiaming Hu, Kaycie Lanpher, Daniela Maizel, Grace Zhai, Helena Solo-Gabriele, Larry Brand, Alberto Caban-Martinez, *University of Miami*

Harmful algal blooms of cyanobacteria (e.g., CyanoHABs) can produce toxins, including microcystins (MCs), that can be aerosolized from contaminated lakes, rivers, canals, and other waterways. Inhalation of aerosolized MCs are thought to be a more potent form of exposure than dermal contact or ingestion, yet little is known about the aerosolization potential and health impacts of inhaled MCs and other CyanoHAB toxins. We measured MCs in both waterways and air in regions of South Florida impacted by HABs and found concentrations of MC in water in excess of drinking water guidelines as well as detectable MC in aerosols. To probe the health impacts of our findings, we bubbled contaminated lake and canal water samples and the generated aerosols were used to expose fruitflies, Drosophilia megalomaster—a model organism with a short enough lifespan to probe both acute and chronic health impacts. Juvenile fruitflies exposed to aerosolized Cyano-HAB toxins had shorter lifespans, altered motor capabilities, and deteriorated synaptic function compared to our control groups. Finally, we investigated mitigation strategies to reduce the inhalation of Cyano-HAB toxins both indoors and outdoors using face masks and air conditioner (AC) filters. Particle transmission efficiencies and toxin filtration efficiencies were measured and for the AC filters were found to scale with the manufacturer-provided filter performance ratings. Up to 80% of small, microcystin-containing aerosols were transmitted through AC filters with low filter performance ratings. Hydrophobic congeners of MC including MC-LF and MC-LW were enriched in aerosols compared to water, with MC-LR being the most abundant form, which has implications for the toxicity of aerosols generated from HAB-contaminated waters. Given that HABs are predicted to increase worldwide, knowledge of the health impacts associated with the inhalation of aerosolized HAB toxins are needed in addition to effective mitigation strategies to prevent airborne exposure.

10ID.1

Transmission of SARS-CoV-2 in the Workplace: Key Findings from a Rapid Review of the Literature. JENNIE COX, Brian Christensen, Nancy Burton, Kevin Dunn, Mikaela Finnegan, Ana Ruess, Cherie Estill, *NIOSH, CDC*

At the beginning of the COVID-19 pandemic, the primary route of transmission of the SARS-CoV-2 virus was not well understood. Information from previous respiratory infectious diseases was the basis for the initial perceptions of different modes of transmission for SARS-CoV-2. To better understand the modes of transmission of SARS-CoV-2, a rapid literature review was conducted from June 22, 2020, to September 23, 2021. 18,616 unique results were identified from literature databases and screened. Of these, 279 key articles were reviewed and abstracted covering critical topics such as environmental/workplace monitoring, sampling and analytical method evaluation, and virus survivability. This presentation describes the results of the rapid literature review, which evaluated the pathways that contribute to transmission as well as the strengths and limitations of current sampling approaches. This review also evaluates how different factors, including environmental conditions, could impact the transmission potential of SARS-CoV-2. A continual rapid review in the midst of a pandemic was very useful for quickly understanding the transmission parameters of the virus and enabled us to comprehensively assess literature, respond to workplace inquiries, and to evaluate our understanding as the science changed. Key findings include that air and surface sampling, and analytical methods, were not generally effective in recovering SARS-CoV-2 viable virus or RNA in many likely contaminated environments (e.g., hospitals with COVID patients). While sampling to detect SARS-CoV-2 is still developing, results are not currently suitable for the definitive determination of worker safety and transmission risk. Therefore, workers and managers must rely on best practices in order to minimize exposure. The development of validated sampling and analysis methods is critical for determining worker exposure to SARS-CoV-2 and to assess the impact of mitigation efforts.

10ID.2

SARS-CoV-2 Detection in Air Samples from Inside Heating, Ventilation, and Air Conditioning (HVAC) Systems-COVID Surveillance in Student Dorms. SINAN SOUSAN, Ming Fan, Kathryn Outlaw, Sydney Williams, Rachel Roper, *East Carolina University*

Detection of SARS-CoV-2 is important for the control of COVID-19. Early detection of SARS-CoV-2 in an area can trigger protective measures, including masking, testing individuals for infection, isolation of those infected, and quarantine of exposed individuals. Wastewater testing has been employed, but sampling is difficult, and extensive processing is needed. We pursued research to detect SARS-CoV-2 in air samples. We sampled air inside HVAC ducts in two large student dormitories and a COVID isolation suite containing student(s) who had tested positive for COVID-19. We assessed four methods to collect air samples: Filter Cassettes, Button Sampler, BioSampler, and AerosolSense sampler. We designed protocols to preserve the RNA in sample collection and processing for direct PCR analysis. Results from air sampling were compared to random testing of students in the dorms. For the two large dorms with a normal student population, we detected SARS-CoV-2 in 11 samples over a 3 month period. When compared with student nasal swab qRT-PCR testing, we detected SARS-CoV-2 in air samples when a PCR positive COVID-19 student was living on the same floor of the sampling location with a detection rate of 75%. For the isolation dorm, we had a 100% SARS-CoV-2 detection rate with the AerosolSense sampler. Our data suggest air sampling may be an important SARS-CoV-2 surveillance technique in office buildings and especially for buildings with congregant living settings (e.g., dorms, correctional facilities, barracks). Future building designs and public health policies should consider the implementation of HVAC surveillance for multiple respiratory pathogens.

10ID.3

Multiplexed Virus Detection at the Point-of-Care (POC) by a Valve-Enabled Sample Preparation Device with Isothermal Amplification. Carlos Mazanas, Md. Mahbubul Alam, Julia Loeb, John Lednicky, CHANG-YU WU, Z. Hugh Fan, *University of Florida*

With expected co-circulation of SARS-CoV-2 and influenza, their early and accurate detection at point-of-care is crucial for reducing their transmission. To address this need, we developed a valve-enabled lysis, paper-based RNA enrichment, and RNA amplification device (VLEAD) for simultaneous detection of SARS-CoV-2 and influenza A viruses. Each side of the device consists of a buffer unit at the top containing 4 wells (lysis buffer, binding buffer, and two wash buffers) for sample preparation, a mixing unit in the middle, and a detection unit at the bottom. Sample preparation process starts by adding a sample into each mixing well, followed by the release of the lysis buffer into the mixing unit. Then, the binding buffer is released to bind the RNA onto the chromatography paper in the detection unit. The wash buffers in the last two wells are then discharged to purify the collected RNA. Afterwards, the detection units are prepared for reverse transcription loop-mediated isothermal amplification (RT-LAMP). Finally, the detection units are added SYBR Green dye for detection of amplicons by color change.

We have demonstrated the specificity of VLEAD by using SARS-CoV-2 and influenza A H1N1 pdm2009. In one experiment, we used the primer set targeting SARS-CoV-2 to test individual RNA of SARS-CoV-2, influenza A H1N1 pdm2009, and CoV-OC43; in the other experiment we used the primer set targeting Influenza A H1N1 pdm2009 to test the same three viruses. Both results confirmed the specific detection of the target virus with no cross-reaction with any of the other two viruses. VLEAD also showed great sensitivity with limit of detection at 10 genome equivalents for SARS-CoV-2 and 0.06 TCID50 for Influenza A H1N1 pdm2009.

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10ID.4

Effect of Deposition Methods (Pipette vs Aerosol) on the Amount of Transfer of DNA attached Polystyrene Latex Bead. Maria King, Jana Kesavan, VIOLETTE RAMIREZ, *Texas A&M University*

Contact transfer of bacteria from fomite can spread diseases and it is important to quantify the amount for risk calculations and for decontamination of surfaces. Controlled laboratory studies can be conducted using bacteria but realistic outdoor tests may require surrogates. DNA attached 1 micrometer Polystyrene Latex microspheres (DNA-PSL) may be a good bacteria surrogate because of the particle size and detection of low concentrations. Pipetting is the common method used in depositing particles onto surfaces; however, this may not represent aerosol deposition such as cough droplets falling onto surfaces. This study evaluated the effect of deposition methods (pipette vs aerosol) on the transfer efficiency (TE) of DNA-PSL. Aluminum, formica and glass slides were selected as test surfaces. A commercial-mesh nebulizer was used to aerosolize liquid at 1 ml/min into a sealed 27 L polypropylene and polyethylene chamber. Pipetted samples were distributed in 80 µL aliquots across the surface. The amount of transfer was determined by wiping the slide with 1.5 in2 parafilm and analyzing the samples. TE of particles was determined by comparing the amount of particulate matter recovered from parafilm to the original deposited amount. Real-time polymerase chain reaction was performed to quantify the amount of DNA in samples. The transfer efficiency of pipetted surface samples at 20% relative humidity (RH) was 5%±1.25% (glass,), 4%±1.25% (aluminum), and 5%±1.34% (formica). At 80% RH higher efficiencies were obtained: 9%±0.13% (glass), 5%±1.75% (aluminum) and 9%±0.36% (formica). For aerosol deposited surface samples at 20% RH, TE was 15%±0.29% (glass), 15%±0.09% (aluminum), and 16%±0.60% (formica). At 80% RH, the values were 14%±0.79% (glass), 13%±0.013% (aluminum) and 15%±0.77% (formica). The TE for pipetted samples was lower compared to aerosolized material. Elevated RH resulted in higher TE for pipetted samples, however, no significant difference was detected for the aerosolized samples.

10ID.5

Investigation of Novel Active and Passive Samplers to Detect SARS-CoV-2 Surrogates. DAVID ALBURTY, David Goad, Pamela Murowchick, Andrew Page, Sydonia Manibusan, Gediminas Mainelis, *InnovaPrep LLC*

The COVID-19 pandemic highlighted a dire need to better understand the presence and transmission of airborne pathogens. Unfortunately, there is still a lack of easy-to-use, inexpensive, and robust samplers for monitoring indoor air that could help address the pathogen-centric medical-focused model of disease and its transmission. These challenges could and are being addressed by the aerosol science and engineering community. Two specific needs for further improvement are 1) a small, quiet, high-volume air sampler and 2) an ultralight zero-power personal sampler. The work presented here discusses results from a test & evaluation series conducted in a bioaerosol test chamber using two currently available solutions, the InnovaPrep Cub sampler and the Rutgers Electrostatic Passive Sampler (REPS). The Cub sampler operates at 200 L/min and uses an electret filter as a collection medium. REPS is based on the permanently polarized ferroelectric film. Both samplers were challenged with aerosolized Bovine Coronavirus as a surrogate for SARS-CoV-2 and other coronaviruses. The samples were analyzed by qPCR. The Cub operated for 10 min, while REPS collected samples for a longer period. Detection and saturation limits of the devices were explored. To improve virus detection, eluted samples were concentrated using CP Select concentrating pipette. The results show the utility of both devices to capture airborne viruses and the complementarity of active and passive samplers to determine short and long-term virus presence and exposures.

10ID.6

Development of a Breathalyzer for Rapid Detection of SARS-CoV-2 Variants. DISHIT GHUMRA, Nishit Shetty, Benjamin Sumlin, Carla M. Yuede, John Cirrito, Rajan K. Chakrabarty, *Washington University in St. Louis*

Coronavirus Disease 2019 (COVID-19) is caused by the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). The COVID-19 pandemic has led to more than 6 million deaths worldwide and poses a significant threat to global health due to its long-term effects on the health of infected individuals. Accurate and fast testing in the early stages of infection is important to mitigate the community spread of COVID-19. In this work, we developed a breathalyzer for rapid detection of SARS CoV-2 which provides an alternative testing platform that is faster, affordable, and more efficient for mass testing than conventional viral diagnostics. We prototyped a device for the collection of exhaled breath condensate (EBC)—an effective and non-invasive method to collect breath—and coupled it with a nanobody-based electrochemical sensor to detect SARS-CoV-2. Inactivated SARS-CoV-2 particles were aerosolized using the Blaustein Atomizing Modules and subsequently sampled into the EBC collector; the gathered aerosols were then analyzed using square-wave voltammetry to detect an oxidation peak current that corresponds to the presence of the virus in a given sample. The device was successful in detecting all variants of concern up to BA.1. Quantitative polymerase chain reaction (q-PCR) of the EBC indicated a virus detection sensitivity of ~10 virions/sample. The current diagnostic setup is able to generate test results within 60 seconds of breathing into the breathalyzer device, and it is highly promising for applications in places/settings that require mass testing such as airports and conference centers.

10RA.1

Functional Group Composition of Organic Aerosols in the IMPROVE Network. ANN DILLNER, Dominique Young, Sean Raffuse, *University of California, Davis*

The Interagency Monitoring of Protected Visual Environments (IMPROVE) is a long-term ambient particulate matter (PM) monitoring network of approximately 160 sites. IMPROVE sites are located throughout the US at primarily pristine locations such as National Parks and Wilderness Areas. PTFE filter samples are collected for 24-hours on small (25 mm) filters with a high (22.8 lpm) flowrate which provides a larger areal density than more common sampling techniques which use 16.7 lpm and 47 mm filters. Carbonaceous aerosols are characterized in IMPROVE as organic carbon (OC) and elemental carbon (EC). Thermal fractions of OC obtained while measuring OC and EC provide operationally-defined partitioning of OA but there is uncertainty in their relationship to atmospheric constituents. In addition, heteroatoms such oxygen (O), hydrogen (H) and others that are associated with the carbon are not measured. Therefore organic aerosol (OA) or organic matter (OM) is not measured directly but is estimated as 1.8 * OC.

One measure of atmospheric constituents of OM is organic functional groups, that is carbon bonded to O, H and other atoms. Other methods measure individual compounds or classify OM composition based on volatility. In this work, we measure organic functional groups and OA across the IMPROVE network using Fourier Transform Infrared (FT-IR) spectrometry measurements. Organic functional groups include aliphatic CH, alcohol OH, carboxylic acid (COOH) groups and non-acid carbonyls (CO) and are measured at all IMPROVE sites from the beginning of 2015 to the middle of 2018. Most of the data is above minimum detection limit due to the high areal density of IMPROVE samples. OM or OA is the sum of the functional groups. We will begin by presenting our quality assurance efforts and will highlight notable trends across regions, seasons, and years.

10RA.2

Concentration of Terpenoid Oxidation Products in Aerosol in the Southeastern U.S. and the Role of Different BVOC Classes. GRAHAM FRAZIER, Gabriel Isaacman-VanWertz, *Virginia Tech*

Biogenic volatile organic compounds (BVOC) represent the primary source of reactive carbon in the atmosphere and contribute to formation of secondary organic aerosol (SOA) through atmospheric oxidants including ozone and hydroxyl radicals. One class of BVOC, sesquiterpenes, have higher reaction rates with ozone compared to other BVOC species and higher SOA yields. However, these and other higher molecular weight chemical classes exist at low concentrations relative to other BVOCs, so their contribution to aerosol formation remains uncertain. While some modelling predicts sesquiterpenes contribute substantially to SOA, several sampling campaigns have observed low concentrations of sesquiterpenes and have suggested that SOA in BVOC-rich locations can be explained without significant contributions from sesquiterpenes. The central uncertainty is therefore whether low concentrations are due to sesquiterpenes being emitted at high rates and reacting quickly with atmospheric oxidants, which would contribute significantly to SOA, or whether emissions of sesquiterpenes are simply insufficient to contribute substantially to SOA formation. To rectify this knowledge gap, we present data from several field deployments to quantify terpenoid oxidation products and provide insight into the importance of sesquiterpenes in comparison to other BVOC classes with regards to their contribution to aerosol. The composition of organic aerosol and aerosol-forming gases were measured by a semi-volatile thermal desorption aerosol gas chromatography (SV-TAG) at several sites in Virginia to provide a representation of different ecosystems in the Southeastern US. This work focuses on presenting concentrations of oxidation products from a variety of terpene classes and seeks to provide constraints on the observed contribution of sesquiterpene oxidation products to aerosol mass.

10RA.3

Process-Level Representation of Organic Aerosols in a Regional Climate Model (WRF-Chem): Processes, Parameterizations, and Predictions for GoAmazon. Charles He, Kelsey Bilsback, ManishKumar Shrivastava, Rahul Zaveri, Christopher Cappa, John Seinfeld, Jeffrey R. Pierce, SHANTANU JATHAR, *Colorado State University*

Organic aerosol (OA) in the atmosphere exerts large impacts on air quality, human health and climate. However, OA predictions always bear large uncertainties, which likely stem from the limited representation of important physical and chemical processes in current 3D models. Prominently, these processes can include the multigenerational aging of precursors to form secondary OA (SOA), formation of highly oxygenated molecules from autoxidation reactions, phase state-limited gas/particle partitioning, heterogeneous oxidation, and particle-phase oligomerization. In previous work, we developed a computationally efficient SOA model (simpleSOM-MOSAIC) to simulate these processes within a kinetic framework. In this study, we integrated simpleSOM-MOSAIC into a regional climate model (WRF-Chem) to investigate the impact of process-level modeling on OA formation and evolution, utilizing the GoAmazon campaign as a case study. The base model, including all kinetic processes, was able to capture the elevated concentration of the OA in the downwind plume of Manaus, and ongoing work will compare model predictions with measurements along a flight track crossing the plume. Monoterpenes remained the primary contributor to SOA formation (>90%) in all simulations due to large emissions and high SOA mass yields. Individual process contributions suggested that the semi-solid phase state reduced SOA formation by 5-15% due to slowed partitioning, compared to instantaneous equilibrium; heterogeneous oxidation reduced SOA formation by 5-10% through fragmentation and evaporation; and oligomerization increased SOA formation by 10-15% through shifts in gas/particle equilibrium, resulting in an oligomer fraction of 20%. Thus, these processes had substantial impacts on the SOA burden. The model can also predict SOA O:C ratio, evolution of the particle size distribution, and the volatility distribution. Overall, this study advocates for the kinetic simulation of SOA-governing processes for improved prediction of its concentration and properties and assessment of its environmental and climate impacts.

10RA.4

The 3rd ARM Mobile Facility in the Southeast United States: Current Plans for Science-Driven Facility Siting, Configuration, Instrumentation, and Outreach. CHONGAI KUANG, Scott Giangrande, Shawn Serbin, *Brookhaven National Laboratory*

The DOE ARM user facility is relocating the third ARM Mobile Facility (AMF3) to the Southeast United States for a five-year deployment starting in the Fall of 2023, with siting focused on Northern Alabama. The Southeast United States is a region characterized by: high vegetative emissions of volatile organic compounds; a wide range in anthropogenic emissions from proximity to rural areas and dense urban cores; biomass burning from periodic prescribed and unplanned burning; and large amounts of secondary organic aerosol. This AMF3 deployment is a unique opportunity to improve understanding and model representation of coupled aerosol, cloud, and land-surface processes in an environment where such processes are strongly driven by local forcings. A defining aspect of this AMF3 deployment is an expectation for long-term observations to account for seasonal to annual variability. Understanding the role of spatiotemporal variability (e.g., atmospheric thermodynamic variability, variation in land-surface properties and seasonality) across aspects of the climate system is a key motivator for AMF3 studies. This is especially true for characterizing the relationships between aerosol and land-surface processes over a diverse patchwork of natural, managed, and urban landscapes found across the region. The Site Science Team (SST) is tasked to help identify the most impactful AMF3 science drivers, locations, key instruments and measurement strategies to address wider climate-process study needs. Building on previous siting criteria, instrument justifications, updates and interactive feedback sessions provided to the broader community, the SST will present its latest planning updates, including recent “site short-list” feedback to map relevant science themes to a narrower subset of potential AMF3 locations. These efforts steer towards a comprehensive accounting (e.g., ‘science plan’) for eventual scientific opportunities as more deployment specifics become available.

10RA.5

Numerical Investigation of Dry Deposition of Dust Particles on Leaves of Coniferous Plants during Dust Storms. Rahul Tarodiya, BORIS KRASOVITOV, Natan Kleeorin, Avi Levy, Itzhak Katra, *Ben-Gurion University of the Negev, Israel*

Dust storms are one of the most significant sources of global atmospheric particulate matter (PM), with serious consequences for human health. During dust storms, daily averages of atmospheric PM concentrations can exceed the WHO's air quality guideline. The present study aims to investigate the effect of forest on PM distribution following dust events in a region prone to dust storms (Northern Negev, Israel). 3D numerical modeling of the particulate flow using a discrete phase model, based on the Eulerian-Lagrangian approach, has been performed to investigate the dust deposition to the vegetation element. The modeling considered several deposition mechanisms namely, the drag force, buoyancy force, the Brownian force, Saffman's lift force, and thermophoretic force. The vegetation element is assumed to be prolate ellipsoid, approximated to the shape of the Aleppo pine trees in the Lahav forest. The validity of the model prediction is evaluated using field measurement data. Further, the particulate flow field, particle deposition pattern, and deposition efficiency on the vegetation element oriented at different inclination angle to the wind flow is determined. The influences of other essential factors such as particle size and wind velocity on deposition efficiency and the deposition velocity of dust particles to the vegetation element are also analyzed and discussed. The results of this study are substantial for assessing the impact of planting semiarid forests on the level of air pollution in adjacent urban areas during dust events.

10RA.6

Correcting for Biases in Filter-Based Aerosol Light Absorption Measurements at the ARM Southern Great Plains Site. JOSHIN KUMAR, Theo Paik, Nishit Shetty, Patrick Sheridan, Manvendra Dubey, Allison Aiken, Rajan K. Chakrabarty, *Washington University in St. Louis*

Measurement of absorption of solar radiation by aerosols is vital for assessing direct radiative forcing, which affects local and global climate. Low-cost and simple-to-operate filter-based instruments, such as Particle Soot Absorption Photometer (PSAP) that collect aerosols on a filter and measure light attenuation through the filter are widely used to infer aerosol light absorption. However, filter-based absorption measurements are subject to unquantifiable artifacts associated with the presence of the filter medium and the complex interactions between the filter fibers and accumulated aerosols. Various correction algorithms (Bond et al., 1999; Virkkula et al., 2005; Li et al., 2020) have been introduced to correct for the filter-based absorption coefficient measurements toward predicting the particle-phase absorption coefficient (Babs). Since previously developed correction algorithms have a fixed analytical form, fundamentally, they are unable to predict particle-phase absorption coefficients with a high degree of accuracy universally: different corrections for rural and urban sites across the world.

In this study, we have analyzed three months of high-resolution ambient data collected in parallel using a PSAP and 3-wavelength photoacoustic spectrometer; both instruments were operated at the Department of Energy's Southern Great Plains user facility in Oklahoma. We implemented the following algorithms to predict particle-phase Babs values from PSAP data and estimate their accuracy – (1) the Virkkula (2010) correction algorithm, (2) the Revised Virkkula algorithm with updated coefficients, and (3) a Random Forest Regression (RFR) machine learning algorithm. The RFR algorithm outperformed predictions by both the Revised Virkkula and Virkkula (2010) algorithms. The wavelength averaged Root Mean Square Error (RMSE) values for predicting Babs using RFR, Revised Virkkula, and Virkkula (2010) algorithms were 0.37, 0.67, and 3.18 Mm-1, respectively.

To further test the potential of the proposed machine learning model, we trained and tested the RFR algorithm on a dataset of laboratory-generated combustion aerosols. The RFR model used the size distribution, uncorrected Tricolor Absorption Photometer based Babs, and Nephelometer Bscat as input variables and predicted particle-phase Babs values within 5% of the reference Babs.

Presently we are working on the application of the RFR algorithm to FIREX-AQ data from NASA DC-8 aircrafts to correct the artifacts of the filter-based absorption measurement instruments using machine learning. Preliminary analysis shows that RFR is capable of accommodating inferences from various instruments and is more accurate in predicting Babs as compared to the traditional equation fitting-based correction algorithms.

11AC.1

Phase State and Relative Humidity Regulate the Heterogeneous Oxidation Kinetics and Pathways of Organic-Inorganic Mixed Aerosol. CHUANYANG SHEN, Wen Zhang, Haofei Zhang, *University of California, Riverside*

Heterogeneous oxidation of organic aerosols is one of the most critical chemical aging processes that influence the organic particle's chemical composition and subsequent physical properties. The inorganic species coexistent with atmospheric organic particles is thought to influence the reactive uptake of gas-phase oxidative species such as hydroxyl radicals (OH). However, very limited previous studies have explored the role of the inorganic salts on the heterogeneous oxidation of organic species in aerosols. This study examines the heterogeneous oxidation of OH radical, the predominant oxidant in the atmosphere, on varying fractions of glutaric acid-ammonium sulfate mixed particles under different RH conditions in a flow tube reactor. The oxidation kinetics and products are analyzed using a gas chromatography mass spectrometer and an ion mobility mass spectrometer for both phase-separated (low-RH) and well-mixed (high-RH) particles as a function of varying organic mass fraction (f_{org}). Results find that under both dry and humid conditions, the increased inorganic fraction will accelerate the oxidation rate of the organic material in aerosol particles. Analysis of the oxidation products also reveals that the enhanced water uptake by the inorganic under humid conditions will favor alkoxy radical fragmentation and inhibit its secondary chemistry.

11AC.2

Hybrid Water Activity – A Novel Framework for CCN Analysis of Sparingly Water Soluble Organic Aerosols. KANISHK GOHIL, Chun-Ning Mao, Dewansh Rastogi, Chao Peng, Mingjin Tang, Akua Asa-Awuku, *University of Maryland*

Organic aerosols are comprised of hundreds of organic compounds either emitted directly into the atmosphere (Primary Organic Aerosols; POAs) or formed due to chemical transformations in the atmosphere (Secondary Organic Aerosols; SOAs). One such class of compounds are aromatic acids that can act as both POAs and SOAs. Phthalic acid (PTA), isophthalic acid (IPTA) and terephthalic acid (TPTA) are some of the significant benzene polycarboxylic acids. The molecular structure of PTA, IPTA and TPTA contains two carboxylic acid groups attached on a benzene ring. PTA, IPTA and TPTA are structural isomers and differ significantly from each other in terms of water solubility which affects their cloud condensation nuclei (CCN) activity. So far, the CCN activity of PTA and IPTA has been studied and explained using the traditional Köhler Theory (KT). The CCN activity and hygroscopicity of TPTA has not been characterized in the past in the context of cloud activity and droplet formation. Moreover, KT can be effectively applied for CCN activity analysis of PTA due to its higher aqueous solubility compared to IPTA and TPTA. In this work, we studied the CCN activity and subsaturated droplet growth for PTA, IPTA and TPTA. As with other hygroscopicity studies, the supersaturated and subsaturated hygroscopicity derived from KT principles do not agree. In response, we developed the Hybrid Activity Model (HAM) by incorporating the aqueous solubility of a solute within an adsorption-based activation framework. Frenkel-Halsey-Hill (FHH)-Adsorption Theory (FHH-AT) was combined with the compound solubility to develop HAM. Analysis from HAM was validated using laboratory measurements of pure PTA, IPTA, TPTA, and PTA-IPTA internal mixtures. Furthermore, the results generated using HAM were tested against traditional KT and FHH-AT to compare their water uptake predictive capabilities for the compounds selected for this work. A single-hygroscopicity parameter was also parameterized based on the FHH-AT and HAM frameworks. The hygroscopicity parameter developed using FHH-AT provided a better quantification of IPTA and TPTA CCN activity as compared to the hygroscopicity parameter based on KT. It was also found that the hygroscopicity parameter based on HAM could successfully simulate the water uptake behavior of the pure and internally mixed samples. Results suggest that the HAM framework can be applied to aerosols of varying aqueous solubility.

11AC.3

Growth Rate Dependence of Secondary Organic Aerosol on Seed Particle Size, Composition, and Phase. DEVON HIGGINS, Michael S. Taylor, Justin Krasnomowitz, Murray Johnston, *University of Delaware*

Atmospheric nanoparticle growth, which is a key process associated with formation of cloud condensation nuclei (CCN), is thought to be dominated by the condensation of condensable organic vapor (COV), as produced in autooxidation reactions when a biogenic precursor is oxidized. However, it has been recently established by our group that seed particle size, phase, and composition affect particle growth in the 40-100 nm size range. When seed particles composed of ammonium sulfate or freshly generated a-pinene SOA were exposed to a-pinene and ozone, they were found to grow by different amounts, which varied with aerosol liquid water (ALW) content. Seed particle growth is represented by the growth yield (GY), which is defined as the fraction of α-pinene molecules that react with ozone to give a product that grows the particle. Overall, SOA seed particles gave the lowest growth yield, which corresponded to the yield of nonvolatile, highly oxidized molecules produced by autooxidation that are able to condensationally grow the particles. Effloresced ammonium sulfate particles gave somewhat higher growth yields and increased with increasing relative humidity, indicating that reactions of semivolatile molecules at the particle surface can contribute to particle growth. Deliquesced ammonium sulfate particles gave the highest growth yields, indicating that reactions of semivolatile molecules within the particle volume can contribute to particle growth. The growth yield for effloresced ammonium sulfate particles was independent of particle size, while liquid-like seed particles (SOA and deliquesced ammonium sulfate) gave somewhat higher growth yields for largest particles studied. These size dependencies suggest that particles grow by both surface- and volume- limited kinetics. The particle growth results will be presented alongside molecular composition measurements via mass spectrometry to discuss the reaction mechanisms responsible for growth under the various conditions studied.

11AC.4

Effect of Condensed-Phase Photochemistry on the Viscosity of Atmospheric Secondary Organic Aerosol Particles. Vahe Baboomian, Giuseppe Crescenzo, Yuanzhou Huang, Fabian Mahrt, Manabu Shiraiwa, A. K. Bertram, SERGEY NIZKORODOV, *University of California, Irvine*

Information on the viscosity of secondary organic aerosol (SOA) particles is needed to predict their role in air quality and climate. Solar ultraviolet (UV) radiation is known to change the chemical composition and mass concentration of SOA. Nevertheless, the effect of solar UV radiation on the viscosity of SOA particles is unknown, leading to uncertainties when predicting their impacts on air quality and climate. This presentation discusses our measurements of the viscosity of SOA aged by exposure to 305 nm UV radiation for 12 days. This is equivalent to a UV exposure of 6–14 days at midlatitudes in summer, and captures typical tropospheric lifetimes of SOA particles. SOA particles were generated by the ozonolysis of d-limonene and α-pinene, two abundant biogenic volatile organic compounds in the atmosphere. Our results indicate that the viscosity of SOA particles can be as much as five orders of magnitudes larger for aged compared to unaged SOA throughout most of the troposphere. We show that this increase in viscosity is consistent with an increase in average molecular mass of the organic molecules constituting the SOA material, as determined by high-resolution mass spectrometry. The increased viscosity likely leads to increased abundance of highly viscous, glassy SOA particles that can possibly act as ice nucleation particles and impact ice cloud formation and climate in the upper troposphere. In addition, our results show that the mixing times of organic molecules within a SOA particle of 200 nm diameter can increase by as much as five orders of magnitude due to UV-aging, with implications for predicting of growth, evaporation, and the size distribution of SOA. Overall, our results, underscore the need to consider the effects of UV-aging when predicting the properties of SOA and their environmental impacts.

11AC.5

Particles' Phase State Variability in the North Atlantic Free Troposphere during Summertime Determined by Different Atmospheric Transport Patterns and Sources. ZEZHEN CHENG, Megan Morgenstern, Bo Zhang, Matthew Fraund, Nurun Nahar Lata, Rhenton Brimberry, Matthew A. Marcus, Lynn Mazzoleni, Paulo Fialho, Silvia Henning, Birgit Wehner, Claudio Mazzoleni, Swarup China, *Pacific Northwest National Laboratory*

Free tropospheric aerosol particles have important but poorly constrained climate effects due to transformations of their Physico-chemical properties during long-range transport. We investigated the chemical composition and provided an overview of the phase state of individual particles that have been long-range transported over the North Atlantic Ocean and were collected on June and July 2014, 2015, and 2017 at the Observatory of Mount Pico (OMP), in the Azores. The FLEXible PARTicle Lagrangian particle dispersion model (FLEXPART) showed that most air masses arrived during the sampling period at OMP originated from North America and recirculated over the North Atlantic Ocean, and they were highly aged (average plume age >10 days). Computer-controlled scanning electron microscopy with an energy dispersive X-ray spectrometer (CCSEM-EDX) results showed that the most abundant particle types were carbonaceous (~29.9 to 82.0 %), sea salt (~0.3 to 31.6 %), and sea salt with sulfate (~2.4 to 31.5 %). Tilted SEM images indicated that most particles (~47 to 99 %) were in the liquid state at the time of collection due to inorganic inclusions. Moreover, we also observed a substantial fraction of solid and semisolid particles (~0 to 30 % and ~1 to 42 %, respectively) during different transport patterns/events, reflecting the particles' phase state variability for different atmospheric transport events and sources. Combining phase state measurements with FLEXPART CO tracer analysis, we found that wildfire-influenced plumes can result in particles with a wide range of viscosities after long-range transport in the free troposphere. We also used temperature and RH values extracted from the Global Forecast System (GFS) along the FLEXPART simulated path to predict the phase state of the particles during transport and found that neglecting internal mixing with inorganics would overestimate the viscosity of free tropospheric particles.

11CA.1

Properties of Biomass Burning Organic Aerosol from Fuel Species in the Southern Great Plains. ELIJAH SCHNITZLER, Katrina Betz, Colton Calvert, Elevia Bruce, Troye Jirka, Nathan Huskins, *Oklahoma State University*

The incidence of severe wildfires in the southern Great Plains, USA, has steadily increased in the last 25 years. The Rhea Fire in 2018, for example, burned roughly 300 000 acres of tallgrass prairie in western Oklahoma. Biomass burning organic aerosol (BBOA) from these grassfires has significant but uncertain effects on climate, as there are many remaining questions regarding its interactions with solar radiation and cloud processes. Using experimental and computational techniques, we are working to contribute insights into the light-absorption and hygroscopicity of BBOA from regionally relevant fuel species, including native tallgrasses collected in summer and winter as well as non-native eastern redcedar, which is associated with higher wildfire risks. BBOA in the absence of elemental carbon is generated by smoldering fuel in a tube furnace. The light-absorption of the BBOA is characterized in terms of the mass absorption coefficient (MAC) using UV-vis spectroscopy, and the dependence on fuel species is explored. The effects of concentration and temperature on absorbance are investigated to probe charge-transfer complexes. The distribution of absorbance, mass, and in turn MAC values across a range of polarity fractions is determined using octanol-water partitioning. The hygroscopicity of the BBOA is measured using a tandem differential mobility analyzer. Furthermore, the evolution of absorption with aging in the aqueous phase is monitored using a photo-reactor. Together, these results will help to better understand the fate and impact of BBOA from wildfires in the southern Great Plains.

11CA.2

Brown Carbon Light Absorption from Wildfire Plumes Related to Low-volatility Organic and Nitrogen-containing Organic Compounds.

NISHIT SHETTY, Pai Liu, Yutong Liang, Benjamin Sumlin, Conner Daube, Scott Herndon, Allen Goldstein, Rajan K. Chakrabarty, *Washington University in St. Louis*

Light absorbing organic aerosol emissions—known as brown carbon (BrC)—can act as short-term climate forcers, and they modify the Earth's radiative budget by interacting with incoming solar radiation. Conventionally, a majority of light absorption by BrC is attributed to specific chemical compound groups such as nitroaromatics and polyaromatic hydrocarbons. Evidence from laboratory studies suggests that low volatility organics, primarily emitted during high-temperature combustion, could contribute significantly to light absorption by BrC aerosols. In this talk, we will present our results on the spectral light absorption properties of BrC aerosol emissions from three wildfires across the western United States. sampled as part of the 2019 Fire Influence on Regional to Global Environments and Air Quality (FIREX-AQ) field campaign. We observed that both the extremely low volatility organic carbon and nitrogen-containing organic compound concentration were associated with an increase in BrC light absorption. We also observed that a significant fraction of the BrC was water-insoluble, with water-insoluble BrC comprising at least 43 ± 11% of the total BrC light absorption.

11CA.3

Carbonaceous Aerosol Fingerprint from Wildfires in California between 2018 and 2022 Using an Advanced Total Carbon - Black Carbon (TC-BC) Method.

MATIC IVANČIČ, Asta Gregorič, Gašper Lavrič, Bálint Alföldy, Irena Ježek, Sina Hasheminassab, Payam Pakbin, Faraz Ahangar, Mohammad Sowlat, Steven Boddeker, Jack Connor, Charity Garland, Jonathan P. Bower, Martin Rigler, *Aerosol d.o.o.*

In recent years, the intensity and frequency of wildfires have noticeably increased in California, mainly as a consequence of climate-related changes in temperature and precipitation patterns. Wildfires are an important source of carbonaceous aerosols (CA) that strongly impact public health on both local and regional scales, and climate change, on a global scale. While it is demonstrated that different CA components may cause a multitude of health impacts, their influence on climate change is not yet fully understood - it not only absorbs light but also scatters it. Therefore, special attention must be paid to CA's apportionment into different components and their possible sources and formation mechanisms. In this study, we used the Carbonaceous Aerosol Speciation System (CASS, Aerosol d.o.o., Slovenia, EU), comprised of two instruments, a Total Carbon Analyzer TCA08 (Rigler et al., 2020) in tandem with an Aethalometer AE33 (Drinovec et al., 2015), for high-time-resolution measurements of total carbon (TC) and black carbon (BC). By integrating different numerical algorithms to high-time-resolution measurements of CASS (i.e., Aethalometer model, EC tracer model, BrC model), we introduce an advanced method to apportion CA into six components based on their optical absorption properties and their primary or secondary origins: $CA = BC_{ff} + BC_{bb} + POA_{BrC} + POA_{non\text{-}abs} + SOA_{BrC} + SOA_{non\text{-}abs}$, where BC_{ff} and BC_{bb} represent fossil fuel and biomass burning related BC components, POA_{BrC} and SOA_{BrC} are the primary emitted and secondarily formed light-absorbing organic aerosols, and $POA_{non\text{-}abs}$ and $SOA_{non\text{-}abs}$ are non-light-absorbing aerosols.

We analyzed the carbonaceous aerosol fingerprints of selected major wildfires between 2018 and 2022 at three stations in California: Berkeley, Los Angeles, and Riverside. First, we used brown carbon (BrC) as a marker for wildfire plumes. The results indicated that light absorption on BrC can increase fractional contribution to the light absorption at 370 nm to more than 50%. Then, we compared the CA components from the selected wildfires to those of the Campfire, the deadliest and most destructive wildfire in California history.

11CA.4

Aqueous Processing of Water-soluble Organic Compounds in the Eastern United States during Winter. MARWA EL-SAYED, Christopher Hennigan, *Embry-Riddle Aeronautical University*

Aqueous multi-phase processes are significant contributors to organic aerosol (OA) mass in the atmosphere. This study characterizes the formation of water-soluble organic matter during the winter in the eastern United States through simultaneous measurements of water-soluble organic carbon in the gas and particle phases ($WSOC_g$ and $WSOC_p$, respectively). The formation of secondary $WSOC_p$ occurred primarily through two pathways: (1) absorptive partitioning of oxygenated organics to the bulk OA and (2) aqueous phase processes. $WSOC_p$ formation through the former pathway was evident through the relationship between the fraction of total WSOC in the particle phase (F_p) and the total OA concentration. Conversely, evidence for nighttime aqueous $WSOC_p$ formation was based upon the strong enhancement in F_p with increasing relative humidity, indicating the uptake of $WSOC_g$ to aerosol liquid water (ALW). The F_p -RH relationship was only observed for temperatures between 0 – 10 °C, suggesting conditions for aqueous multi-phase processes were enhanced during these times. Temperature exhibited an inverse relationship with ALW and a proportional relationship with aerosol potassium. ALW and biomass burning precursors were both abundant in the 0 – 10 °C temperature range, facilitating aqueous $WSOC_p$ formation. To assess the impact of particle drying on the $WSOC_p$ concentrations, the particle measurements alternated between ambient and dried channels. No change was observed in the concentration of particles before and after drying, indicating that the $WSOC_p$ formed through the uptake of $WSOC_g$ into OA and ALW remained in the condensed phase upon particle drying at all temperature ranges. This work contributes to our understanding of sources, pathways, and factors affecting aqueous aerosol formation in the winter.

11CA.5

Cloud Condensation Nuclei (CCN) Activity of Black Carbon Mixed with Low Aqueous Solubility Organics. KANISHK GOHIL, Reese Barrett, Dewansh Rastogi, Chun-Ning Mao, Akua Asa-Awuku, *University of Maryland College Park*

Black Carbon (BC) is the second most important anthropogenic emission in the atmosphere. BC is produced from the incomplete combustion of fossil fuels and biomass. BC molecular composition and morphology vary depending on the source and BC combines with other organic and inorganic species present in the atmosphere. BC accounts for large uncertainties in the net aerosol indirect effect. BC is inherently insoluble in water and hydrophobic but is known to display water uptake behavior either due to its wettable nature or due to other species that are mixed with BC. Past studies show the application of Kohler theory and Frenkel-Halsey-Hill (FHH) adsorption theory for the analysis of pure and coated epoflex and regal BC and the characterization of BC CCN activity. In this work, we used vulcan BC to study its interaction with insoluble organics and CCN activity analysis. We used BC mixtures with low water solubility aromatic acids (phthalic acid, isophthalic acid, and terephthalic acid) in this work. We compared the CCN activity of BC-aromatic acid mixtures with pure BC using three different CCN models - traditional Kohler theory, FHH adsorption theory, and hybrid activity model. Analysis revealed that the CCN activity of pure BC enhances more than twice when aromatic acids are mixed with it. Furthermore, the CCN activity of BC mixed with aromatic acids showed a trend similar to pure aromatic acids. In addition to CCN measurements, we performed transmission electron microscopy (TEM) imaging of pure and mixed BC particles. Results show a size-dependent trend relative to whether pure BC, pure aromatic acid, or a mixture would constitute the aerosol population.

11EI.1

Secondary Organic Aerosol and Gas-Phase Products from Chlorine-Initiated Oxidation of Decamethylcyclopentasiloxane (D5). KRISTI MCPHERSON, Nirvan Bhattacharyya, Lea Hildebrandt Ruiz, Pawel K. Misztal, *University of Texas at Austin*

Decamethylcyclopentasiloxane (D5) is a ubiquitous gas phase pollutant emitted by personal care products and observed in concentrations of up to 1100 ng m^{-3} outdoors and 56,000 ng m^{-3} indoors. While D5 itself is considered non-toxic, the impacts of its oxidation products on air quality and health are less clear. Investigations of D5 oxidation by hydroxyl radicals (OH) have shown the potential for secondary organic aerosol (SOA) formation; however, D5 oxidation by chlorine radicals (Cl) and its potential to form SOA has not been as thoroughly studied. Experiments on Cl-initiated D5 oxidation in this work have shown that at high chlorine concentrations, which can occur in indoor environments, SOA yields range from 30% to 170%. This work also investigates gas phase products, which included D5 rings with various functional group substitutions, $C_wH_xO_ySi_z$ fragments, and chlorinated species. Other findings include evidence for Cl-initiated oxidation of D5 under LED lighting conditions (which simulate indoor lighting conditions) and potential issues with detecting Si-containing particles in the Aerosol Chemical Speciation Monitor (ACSM). The effect of NO_x on this reaction system was also examined.

The Cl-initiated oxidation of D5 was studied in seeded chamber experiments with varying D5 and Cl_2 concentrations. Particle and gas-phase products were analyzed with an ACSM, a Scanning Electrical Mobility Spectrometer (SEMS), an Iodide-mode Chemical Ionization Mass Spectrometer (I-CIMS) with a Filter Inlet for Gases and Aerosols (FIGAERO), a Proton-Transfer-Reaction Mass Spectrometer (Vocus-2R-PTRMS), and monitors for O_3, NO_x and NO_2.

11EI.2

Primary and Secondary Organic Aerosol Formation from Asphalt Pavements. MACKENZIE HUMES, Jo Machesky, Drew Gentner, Sunhye Kim, Oladayo Oladeji, Neil Donahue, Albert A. Presto, *Carnegie Mellon University*

Asphalt is ubiquitous throughout urban areas worldwide. Asphalt emits gas-phase organic compounds spanning a wide range of volatility, from volatile organic compounds to low-volatility species. The emission rate and composition depend strongly on the temperature and age of the asphalt. For example, Khare et al. showed that emissions are significantly higher at application temperatures (~140°C) than summertime road surface temperatures (~50-70°C), and that the composition of the emissions depends on factors like the presence of UV radiation. Khare et al. also estimated that asphalt paving is a major missing source of intermediate and semivolatile organic compounds in southern California; however, additional studies are necessary to further constrain its contribution to urban particulate matter.

In this study, we evaluate the production of primary and secondary organic aerosols (SOA) from asphalt-related emissions. Fresh and aged roadway asphalt samples were collected from road-paving operations in Pittsburgh and stored in a chemical freezer. Samples were heated fresh and after one month of aging at ambient temperature to either common application temperature (~140°C) or peak summertime road surface temperature (~70°C). The emitted gas-phase vapors were flushed into a smog chamber containing ammonium sulfate seed particles that served as a condensation sink. SOA was then generated via the photo-oxidation of the emissions under high-NOx conditions typical of urban chemistry.

Particle size distributions and composition were determined via scanning mobility particle sizer and an aerosol mass spectrometer respectively. Gas-phase emissions were tracked via Iodide-adduct chemical ionization mass spectrometer and proton transfer reaction mass spectrometer. We compare the aerosol mass spectra of the laboratory-generated asphalt OA to recent ambient data collected adjacent to an asphalt manufacturing plant and at an active road-paving site. Overall, we characterize an understudied but considerable source of organic emissions, demonstrating asphalt's role in urban SOA and gas-phase oxidation product formation over different timescales.

11EI.3

Anthropogenic Secondary Organic Aerosol and Ozone from Asphalt-Related Emissions. KARL SELTZER, Venkatesh Rao, Havala Pye, Benjamin Murphy, Bryan Place, Peeyush Khare, Drew Gentner, Chris Allen, David Cooley, Rich Mason, Marc Houyoux, *U.S. EPA*

Advances in observational techniques have provided an unprecedented view into the chemical composition of organic emissions. This includes highly detailed chemical characterization of gas-phase organics in the semi-to-intermediate volatility range, which are efficient secondary organic aerosol (SOA) precursors and have historically been neglected in emissions inventories used for air quality modeling applications. Recent work has identified reactive organic carbon from asphalt as a considerable and previously unaccounted source of SOA precursor emissions in urban areas. Here, we leverage source measurements from recent work to construct a bottom-up inventory of asphalt-related emissions for the United States. Our bottom-up inventory includes hot- and cold-mix application processes, as well as emissions from roofing-related asphalt materials. We then comprehensively reflect our inventory in the Community Multiscale Air Quality (CMAQ) model using the newly developed Community Regional Atmospheric Chemistry Multiphase Mechanism (CRACMM) to quantify the subsequent enhancements in anthropogenic SOA and ozone resolved throughout the United States.

11EI.4

Formation of Secondary Organic Aerosol from Paint Emissions. REINA BUENCONSEJO, Yuyang Peng, Ryan Ward, Benjamin Schulze, Jennifer Kaiser, Nga Lee Ng, John Seinfeld, *California Institute of Technology*

Volatile chemical products (VCPs) are an increasingly important apportionment of volatile organic compound (VOC) emissions. VCPs are also estimated to have a greater secondary organic aerosol (SOA) formation potential than gasoline exhaust, gasoline fuel, and diesel exhaust. In particular, architectural coatings, inks, and adhesives are estimated to have an emission factor approximately two orders of magnitude greater than estimates for on-road gasoline emission factor. Therefore, it is important to characterize the effects of VCPs on atmospheric secondary organic aerosol (SOA) and its formation to better resolve discrepancies between SOA observations and models.

This work looks at water-based and oil-based paints. We aim to quantify SOA yields from these paints as well as characterize their VOC emissions as a function of time. We inject a variety of different paints into a 19 m^3 environmental smog chamber and oxidize via hydrogen peroxide precursor and ultraviolet lights centered around 350 nm. SOA yields are quantified via a custom-built scanning mobility particle sizer. Gas-phase compounds are detected using a CF_3O^- chemical ionization quadrupole mass spectrometer and a proton transfer time of flight mass spectrometer.

We find that oil-based paint is comprised of several VOCs known to form SOA, such as toluene and xylene. The water-based paint is comprised of smaller molecular weight VOCs such acetone, methanol, and propanol. Therefore, the oil-based paint produces roughly an order of magnitude greater SOA volume concentration. This work is relevant to urban environments like the Los Angeles Basin where vehicular emissions continue to decrease but where VCPs are continuing to play an important role in air quality and indoor air quality where paint may be used.

11EI.5

Secondary Organic Aerosol from Oxygenated Precursors: Mass Yields, Composition, and Parameters for Chemical Transport Models. SHANTANU JATHAR, Abraham Dearden, Allison Piasecki, Ann M. Middlebrook, Katelyn Rediger, Matthew Coggon, Cort Zang, Tucker Melles, Megan Willis, Chelsea Stockwell, Lu Xu, Carsten Warneke, Rebecca Schwantes, Brian McDonald, Christopher Cappa, Delphine K. Farmer, *Colorado State University*

Volatile chemical products (VCPs) consist of hydrocarbons (HCs) and oxygenated volatile organic compounds (OVOCs), both of can oxidize in the atmosphere to form secondary organic aerosol (SOA). While the SOA contribution from VCP HCs can be estimated from historical data on alkanes, alkenes, and aromatics, there are few laboratory studies that can be used to inform SOA production from VCP OVOCs. This has meant that the contribution of VCP OVOCs to anthropogenic SOA has remained uncertain. In this work, we performed a set of experiments in a 10 m^3 environmental chamber at Colorado State University to study the oxidation chemistry of VCP OVOCs leading to SOA formation. We performed a total of sixteen chamber experiments on eleven different VCP OVOCs - representing a diversity of compound classes - under moist (relative humidity ~ 55%) and moderate NO_X (30 ppbv) conditions. Gases and vapors were characterized using mass spectrometers while particles were measured using mass spectrometry and sizing, counting, and filter-based instruments. The findings outlined below are preliminary. Consistent with previous work, benzyl alcohol, carbitol, and butyl carbitol exhibited rapid and large SOA production with mass yields that exceeded 30% and texanol, D4 siloxane, butyl acetate, and dipropylene glycol formed little to no SOA. Surprisingly, dipropylene glycol methyl ether and dipropylene glycol butyl ether were not as efficient in forming SOA compared to glycol ethers like carbitol and butyl carbitol. Furfural oxidation resulted in high SOA mass yields (20%), with evidence that approximately half of the SOA was formed via aqueous pathways. Ongoing work is focused on (i) understanding the influence of the carbon and oxygen numbers and functional moieties on SOA mass yields and O:C ratios and (ii) development of volatility basis set-based parameters for use in chemical transport models.

11ID.1

Heterogeneity in Airborne Transmission of COVID-19 by Respiratory Aerosols. PRASAD KASIBHATLA, *Duke University*

The recognition of the importance of airborne transmission of the SARS-CoV-2 virus by respiratory aerosols has spurred several research groups to develop and apply simple mechanistic aerosol models to investigate COVID-19 outbreaks associated with specific events. These studies have highlighted the importance of layered, non-pharmaceutical intervention strategies such as masking, ventilation, and air cleaning to mitigate transmission risk. To date, however, there is a disconnect between these micro-scale mechanistic aerosol models and the macro-scale epidemiological models that have been used to study large-scale COVID-19 disease dynamics.

In this talk, I will present a Monte Carlo analysis of transmission risk and secondary infections arising in social settings by modeling aerosol transmission of COVID-19 in indoor locations in the United States. I will show that variability of viral load among index cases plays a key role in shaping the variability in transmission risk at these locations. I will further demonstrate that aerosol transmission is consistent with the observation that COVID-19 transmission is overdispersed and will provide a mechanistic explanation for this large-scale characteristic of the pandemic. Implications of this finding with regards to the effectiveness of non-pharmaceutical interventions in curbing the pandemic will be discussed.

11ID.2

Simulating Near-field Enhancement in Airborne Transmission with a Quadrature-based Model. LAURA FIERCE, Alison Robey, Cathrine Hamilton, *Pacific Northwest National Laboratory*

Airborne pathogens are transmitted when pathogen-laden respiratory particles are expelled from an infectious person, deposit to the respiratory system of a susceptible person, and cause infection. Some respiratory particles are small enough to remain suspended and contribute to long-range airborne transmission, but exposure to infectious particles is greater in the expiratory jet of an infectious person than in a well-mixed indoor space. Processes governing short-range airborne transmission depend on many parameters that are inherently variable and often poorly constrained, such as the pathogen loading in expelled particles, their variation with respect to size, and the risk of infection in the new host for a given pathogen dose, but uncertainty in model parameters is not easily explored with existing techniques. Some of the most advanced mechanistic modeling studies have used Monte Carlo approaches, but these techniques are computationally expensive, which limits the number of simulations that can be performed. Here we introduce the Quadrature-based model of Respiratory Aerosol and Droplets as an efficient framework for representing short-range and long-range airborne transmission within indoor spaces. We characterized short-range enhancements in airborne exposure across thousands of model scenarios, evaluated the impact of different combinations of controls, and identified the factors that drive variability in the modeled risk of infection across the ensemble of scenarios. We show that exposure to airborne pathogens is enhanced by orders of magnitude during close interactions with an infectious person relative to exposure in a well-mixed room. The horizontal extent of short-range enhancements in airborne transmission extends beyond the travel distance of large droplets.

11ID.3

Modeling of Virus-contained Particle Removal in a Classroom Using Portable Air Purifiers. BO YANG, Andy Fox, John Zhang, David Buckley, Dong Fu, Qihong Nie, Ali Amadeh, *3M Company*

Many students have been tested positive since the COVID-19 pandemic, which was caused by the Coronavirus, SARS-Cov2, and its variants. Recent studies showed that the virus can be transmitted in the classroom as airborne particles. Air purifiers have been adopted as one of the ways to reduce the exposure of humans to the coronavirus. Experimental measurement with portable air purifiers equipped with HEPA filters has been reported to be able to reduce airborne particle concentrations in classrooms. The goal of this study is to predict the performance of using portable air purifiers in a classroom. A computational fluid dynamics (CFD) model coupled with aerosol dynamics was built to simulate the flow field, particle evaporation, and particle deposition. The numbers of air purifiers and their locations were investigated. The plexiglass shield's impact on the flow field and particle trajectories were analyzed. Our findings indicate that the air purifier locations are important, and the plexiglass shields could capture large particles (diameter > 100 µm), but they may decrease the air purifier performance.

11ID.4

Mucin Transiently Mitigates the Loss of Coronavirus Infectivity in Artificial Saliva. ROBERT ALEXANDER, Jianghan Tian, Allen E. Haddrell, Henry Oswin, Daniel Hardy, Edward Neal, Mara Otero-Fernandez, Jamie Mann, Tristan Cogan, Adam Finn, Andrew Davidson, Darryl Hill, Jonathan P. Reid, *University of Bristol*

Evidence indicates viral pathogens such as SARS-CoV-2 can be rapidly spread though the transmission of aerosolized expiratory secretions in the form of droplets or particulates. Understanding the fundamental aerosol parameters that govern how such pathogens survive whilst airborne is essential to understanding and developing methods of restricting their dissemination. Pathogen viability measurements made using Controlled Electrodynamic Levitation and Extraction of Bioaerosol onto Substrate (CELEBS) in tandem with comparative kinetics electrodynamic balance (CK-EDB) measurements, allow for direct comparison between viral viability and evaporation kinetics of the aerosol as a function of time.

Although the main constituent is water (>95%), respiratory saliva is a mixture of mucus, cellular debris and immunological factors. The physiochemical properties of saliva are heterogenous over time and dependent on the age, diet and disease state of an individual. Using real saliva to experimentally model the infectivity of pathogens in the aerosol phase is challenging as a result of this variability. Consequently, model respiratory fluids such as artificial saliva or tissue culture media are used to replicate the evaporation dynamics of expired respiratory secretions in a controlled procedure.

Here, we report the survival of a coronavirus, the Mouse Hepatitis Virus, in model artificial respiratory fluids to determine the suitability of artificial salvia as a surrogate for clinical saliva samples. We see a comparable loss of infectivity of MHV in the aerosol phase in artificial saliva and growth media, indicating that the physicochemical properties and evaporation dynamics that drive the loss of viral infectivity are the same. Further, we will show that the inclusion of clinically relevant mucin concentrations to the samples result in a transient protection of the virus over only a timescale of 2 mins. We also will confirm that aerosol pH and phase change are significant factors determining virus infectivity.

11ID.5

Optimized Design to Reduce Environmental Effects on Bioaerosols. Meiyi Zhang, Tatiana Baig, BROOKE SMITH, Hyoungmook Pak, Gabriela Ramos, Violette Ramirez, Sunil Kumar, David Klassen, Maria King, *Texas A&M University*

Illnesses caused by airborne pathogens, including the recent SARS-CoV-2 coronavirus pandemic and frequent outbreaks of bacterial illnesses, have severe human health consequences, and require effective treatment strategies. However, antiviral drugs are limited, and few novel antibiotic classes are in development today. Viral infectivity and antimicrobial resistance (AMR) of bacteria pose increasing threat to global public health. 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 may contribute to triggering resistance in 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 using biolayer interferometry and molecular dynamics simulation demonstrates that different environmental conditions affect the binding kinetics of the spike (S) protein and receptor binding domain (RBD) of SARS-CoV-2 to different surface materials. Test results with bacterial aerosols show that aerosolization not only exerts mechanical stress on bacteria, but also affects their cell membrane, indicating correlation with the airflow triggering resistance to antibiotics that inhibit cell wall synthesis. Although bacteria are robust creatures, environmental conditions, including the direction of airflow 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 and residence time of contaminated air. Computational airflow models recently developed in this study show that facility layout strongly affects the transport and behavior of bioaerosols, opening new avenues for engineering to reduce the adverse responses triggered by environmental effects and combat their spread.

11IM.1

Culebra Aerosol Research Lidar Project, Description and First Results. JENS LAUTENBACH, Pedrina Terra, Josef Hoeffner, *Arecibo Observatory - University of Central Florida*

This presentation outlines an instrumental description of the Culebra Aerosol Research Lidar (CARLA) and presents the first results from the CARLA Project. CARLA was developed at the main site of the Arecibo Observatory, Puerto Rico and is undergoing operation tests before it is deployed at the Remote Optica Facility of the Arecibo Observatory in Culebra Island. It provides the scientific community with data on aerosol vertical distribution over time at a Caribbean location. This includes Dust coming across the Atlantic Ocean from the African continent. African Dust plays an essential role in the Caribbean lower atmosphere because it influences hurricane formation, weather, and the health of our population, among others.

High Spectral Resolution Lidar (HSRL), like CARLA, can directly retrieve the aerosol backscatter and extinction. The HSR technique has the highest accuracy of all aerosol lidar (Mona et al., 2012). As described in Mona et al. 2012, p. 7: "this technique utilized the difference in the Doppler frequency shifts produced by photons scattered by molecules (random motion) and by particles (motion determined by wind and turbulence)."

CARLA uses a continuous wave tapered amplifier diode laser modulated with 4 kHz and cleaned up by a polarizing beam splitter to send out highly polarised laser pulses in the atmosphere. The backscattered signal from the atmosphere is then directed to the three-channel receiver unit by a 40 cm telescope with a FOV of 100 µrad. The first channel uses a 10 nm Bandpass filter to receive the backscattered Rayleigh (molecules) signal. An Etalon is installed in the second and third channel as HSR filter, followed by a 10 nm Bandpass filter to retrieve the Mie (particles) backscattered signal. The two HSR-channels are laid out to measure both polarisation components of the Mie signal. By applying this technique, CARLA measures molecular (Rayleigh) scattering and particle (Mie) scattering with both polarisations to determine solid particles and liquid droplets in the atmosphere.

Apart from the scientific objectives, this project aims to increase opportunities for the educational system through outreach activities for Puerto Rico's K-12 schools and university students to perform hands-on research experiences. Some students have already benefitted from this opportunity.

11IM.2

Detection of Bioaerosol Based on Single Particle Differential Circular Polarization Scattering. YONG-LE PAN, Aimable Kalume, Jessica Arnold, Chuji Wang, Joshua Santarpia, *U.S. Army Research Laboratory*

Real-time detection and characterization of bioaerosol has been an important research topic for health and environment sciences. Currently the early warning bioaerosol detection systems are mainly based on fluorescence, elastic scattering etc., optical methods, but they either have a high false alarm rate or are still too expensive. These inconveniences led us to develop new early-warning biosensor with low cost and low false alarm rate.

It was reported that DNA helical structures in biological molecules have non-zero circular intensity differential scattering (CIDS, normalized Mueller scattering-matrix element S14) than that from isotropic particles. So far, CIDS measurements have been only carried out on suspension samples, with a polarization modulator and a rotating detector due to its ultra-weak signals (10^{-3}-10^{-6}). Such complex laboratory instrumentation is not readily deployable as a field biosensor.

Here, we report an advanced design for measuring CIDS from single aerosol particles without any moving parts or modulator. The single particle CIDS phase function is obtained using a reflector to project scattering light at different angles onto an ICCD detector instead of a rotating detector. The differential signals were obtained from a particle interacting with two illuminating laser beams with left- and right-circular polarizations, which were produced by fixed optical components without any modulator. This innovative setup, significantly, shortens the measurement times from tens of minutes to tens of micron seconds. Measurements of CIDS phase functions from single aerosol particles of B. subtilis, E. coli spores, MS2 bacteriophage, Yersinia rohdei, DNA-tagged polystyrene (PSL) microsphere, tryptophan, PSL microsphere, atmospheric aerosol particles are carried out using this system. The results showed that DNA contained bioaerosol particles (e.g. B. subtilis spores) have at least three times stronger CIDS signals than non-bioaerosol particles (e.g. PSL microspheres). This newly developed system gives a promise for an innovative early-warning biosensor with low cost and low false alarm rate.

Acknowledgements
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11IM.3

Simultaneous Scaling of Spatiotemporal Representativeness for Concentration Mapping and Microphysical Properties Measurement of Aerosols. Daniel Cantin, OVIDIU PANCRATI, Denis Panneton, Pascal Dufour, Jonathan Fortin, Daniel Landry, Jean-François Cormier, François Châteauneuf, *INO*

The challenges in assessing aerosols effects and impacts are partly due to incomplete knowledge of spatiotemporal variabilities of their physicochemical and optical properties. Proper spatiotemporal representativeness is thus essential for a wide range of applications, including indoor and outdoor air quality, occupational health and safety, and assessment of fugitive anthropogenic aerosol sources. To respond to these needs, INO has developed a LiDAR and a local in-situ monitoring platforms that are targeting aerosols detection and characterisation at different spatiotemporal scales.

Results from a compact portable LiDAR, called Sentinelle, are first presented. These were obtained in simulated conditions facility, as well as in industrial environment, and proved the instrument capacity to provide a representative mapping of aerosol dispersion at scale covering up to multiple hundred meters. The observed behaviors are used to identify/confirm the aerosol emission origin and their movement in large areas. Recent results showed the sensitivity of an automated calibration procedure with respect to the particle size distribution and aerosol composition, which frequently contributes to biased calibration responses. To increase the accuracy in aerosol concentration monitoring, the continuous measurements of particle size distribution and knowledge of composition are therefore required. Based on an in-house patented approach, the in-Situ Individual Particle Sizer (iSIPS) is an easily deployable, low maintenance prototype providing continuous and real-time particle size distribution measurements. This technology is non-intrusive, does not require air sampling through pumping or ventilators and thus provides a very convenient solution for continuous operation in remote locations.

The presented work will detail the potential synergies between these two technological solutions and latest experimental results and supportive simulation results. The overall solution enabled by these technologies under development directly addresses the multi-scale challenges of a realistic ground-truthing of global aerosol monitoring from a spatiotemporal point of view.

11IM.4

Characterization of an Augmented Version of the Printed Optical Particle Spectrometer for Integration into Multi-Instrument Aerosol Sampling Systems. SABIN KASPAROGLU, Mohammad Maksimul Islam, Nicholas Meskhidze, Markus Petters, *North Carolina State University*

The Printed Optical Particle Spectrometer (POPS) is a light-weight, low-cost instrument for aerosol number concentrations and size distributions measurements. Here we report on modifications of the Handix Scientific commercial version of the POPS to facilitate its use in multi-instrument aerosol sampling systems. The flow system is modified by replacing the internal pump with a needle valve and a vacuum pump. The instrument is integrated into closed-flow systems by routing the sheath flow from filtered inlet air. A high-precision multichannel analyzer card (MCA) is added to sample the analog pulse signal. The MCA card is polled at 10 Hz frequency using an external data acquisition system and removes the count-rate limitation of 10,000 particles s^{-1} associated with the POPS internal data acquisition system. The MCA card enables integration of the POPS into larger setups that require precise time stamping and clock synchronization, especially in field measurements (e.g. eddy-covariance flux measurements, aircraft sampling). The 90/10 rise and fall times were measured to be 0.17 s and 0.41 s at a flow rate of 5 cm^{-3} s^{-1} and provide a sampling frequency of ~1-2 Hz below which the amplitude of measured fluctuations is captured with > 70% efficiency. We also integrated the POPS into the dual tandem DMA system, which generates dimer particles. We show that the pulse-height response increases upon dimer coalescence. The magnitude of the increase is broadly consistent with the change in light scattering amplitude predicted by the T-matrix method, which can be used to detect phase transitions occurring in agglomerated particles. We anticipate that this augmented version will extend utilization of the POPS for field and laboratory applications.

11IM.5

Where'd Those Particles Come From? Impactor Non-idealities, Multiple Charging, and Optical Measurement Biases. JAMES RADNEY, Chun-Ning Mao, Akua Asa-Awuku, Christopher Zangmeister, *National Institute of Standards and Technology*

Multiple charging is a problem that has received significant attention in aerosol science that can be especially problematic for optical measurements as particle scattering and absorption cross sections are a strong and non-linear function of size; aerosol extinction cross sections (C_{ext}, the sum of absorption and scattering) can exhibit even stronger dependencies. Thus, C_{ext} measurements utilizing only size selection by a differential mobility analyzer (DMA) require the use of charge correction algorithms to account for the presence of larger particles bearing multiple charges. One fundamental assumption in these algorithms is that above some critical size the population of particles is zero thus imposing an upper size limit that is often enforced with an impactor. Ideally, impactor performance is described by a Dirac delta function, with a well-defined cut-point diameter above (below) which particle transmission is 0 % (100 %). In reality, particle transmission efficiency as a function of size has a finite slope and must instead described by the cut-point diameter, D_{50}, where particle transmission is 50 %. Here, we demonstrate that impactor non-idealities (or damage) can allow for an unexpected population of multiply charged particles larger than D_{50} to be present. Harnessing the sensitivity of a cavity ring-down spectrometer (CRD), which measures aerosol extinction, we demonstrate that measurements of C_{ext} utilizing size selection only versus size and mass selection – which removes the contribution of multiply charged particles – may only converge at sizes larger than D_{50} demonstrating the presence of this unexpected population of multiply charged particles. Failure to account for these particles can lead to significant deviation in inferred particle optical properties when performing refractive index retrievals or radiative forcing calculations.

11NM.1 (Invited)

Aerosol Synthesis of MOFs-based Functional Materials: Fundamentals and Applications. WEI-NING WANG, *Virginia Commonwealth University*

Metal-organic frameworks (MOFs) have attracted much attention during the past years due to their unique properties, including tunable porous structure, high surface area, and rich surface chemistry. Endorsed by these features, MOFs find a variety of applications, such as gas capture and separation, catalysis, drug delivery, and sensing. MOFs are conventionally synthesized via wet-chemistry methods, such as hydrothermal and solvothermal methods, which, however, suffer from long reaction durations, inhomogeneous mixing, and limited batch processes. To address these issues, we have developed a microdroplet-based nanomanufacturing process to fabricate MOFs-based functional materials with controlled nanostructures in a rapid, continuous, and scalable manner. The mechanisms of rapid formation of MOFs inside the microdroplets were investigated by both experimental and theoretical approaches. Further, we have also developed strategies to integrate MOFs with semiconductors to form hybrid photocatalysts for various environmental applications, such as gas adsorption, CO_2 photoreduction, and pollutant degradation. The quantitative mechanisms of gas adsorption, activation, and charge transfer within the hybrid nanostructures were explored by various in-situ techniques, such as diffuse reflectance infrared Fourier transform spectroscopy (DRIFTS), photoluminescence (PL) spectroscopy, and X-ray photoelectron spectroscopy (XPS), coupled with density functional theory (DFT) calculations.

11NM.2

Exploring the Role of Nanoscale Catalysts Synthesized via Spray Flame Aerosol Reactor for Single Step CO2 Hydrogenation to Dimethyl Ether. ONOCHIE OKONKWO, Komal Tripathi, Sonal Asthana, Yiming Xi, Sujit Modi, Kamal Kishore Pant, Pratim Biswas, *University of Miami*

The direct conversion of CO_2 to dimethyl ether (DME) is regarded as an innovative approach for recycling CO_2. Compared to the conventional two-step process which involves methanol synthesis and subsequent methanol dehydration to DME, the direct DME synthesis overcomes the thermodynamic limitation of methanol synthesis and results in process intensification because two reactors are integrated into a single reactor. Consequently, the direct DME synthesis process lowers capital and operating costs, while offering a sustainable route for utilizing carbon dioxide [1].

A highly selective Cu/ZnO/MgO admixed with γ-Al_2O_3 catalyst for direct DME synthesis from $H_2/CO/CO_2$ mixture has been produced by precipitation [2]. Also, Cu/ZnO/ZrO_2 admixed with ZSM-5 catalyst for CO_2 hydrogenation to DME has been produced by precipitation [3]. The precipitation process involves several steps and requires long times for catalysts synthesis. To overcome the limitations of the precipitation process, the flame synthesis route is used to obtain the same catalysts. Flame synthesis is an easily scalable, continuous, single step synthesis method for catalyst manufacture [4].
In this work, Cu/ZnO/MgO and Cu/ZnO/ZrO_2 catalyst is synthesized via flame synthesis, characterised, and explored for DME synthesis. The flame synthesized catalyst activity, selectivity, and stability for DME synthesis is compared to that prepared by co-precipitation to demonstrate its superior performance. The characterization results reveal the structural characteristics which provides insight to describe the performance of the flame synthesized catalyst. Altogether, flame synthesis is used to elucidate the governing aspects for designing high performance catalysts for CO_2 hydrogenation.

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[2] A. Sonal, et al., Energy & Fuels 36:5 (2022) 2673-2687.
[3] S. Rajan, et al., Fuel 318 (2022): 123641.
[4] S. Li et al., Progress in Energy and Combustion Science, 55 (2016) 1-59.

11NM.3

Flame-based Aerosol Synthesis of High Entropy Oxide Nanoparticles. Shuo Liu, MARK SWIHART, *University at Buffalo - SUNY*

Recent decades have witnessed great advances in the ability of aerosol synthesis processes to tune nanomaterial properties, such as particle size, structure, and morphology, but the ability of aerosol processing to access new regions of composition space is less well-explored. In 2015, the concept of “high-entropy ceramic” materials was presented in a report of a $(MgCoNiCuZn)O_x$ solid solution oxide with more than 5 elements in near-equiatomic concentrations in a single rock salt crystal phase. As a highly disordered, multicomponent, and often metastable system, high-entropy ceramics can exhibit interesting and useful new properties, like high-temperature stablity, extreme lattice distortions and abundant oxygen vacancies. New and unexpected properties may emerge upon tuning the cation composition. Several methods have been developed to fabricate nano-sized high entropy nanomaterials, including carbo-thermal shock, laser ablation, and spark discharge, but these routes often face barriers of scalability due to the complex processes, low yield, and high energy requirements. Here, we reported a continuous, low-cost, and scalable flame aerosol process to synthesize high-entropy oxide aerosols. For this, an aqueous precursor containing multiple metal salts is delivered to the flame reactor and atomized into microdroplets within which evaporation and reaction drive formation of solid nanoparticles. The reactor resistance time (~0.05 s) is much shorter than to the time required for phase separation by solid diffusion, so the initial high-entropy state in the droplet precursor can be retained in the product. Rapid quenching with diluting nitrogen prevents phase separation, so a single ceramic phase can be obtained. The reactor environment can be tuned to oxidizing or reducing conditions to influence stoichiometry and oxygen vacancy concentration. We demonstrate the generality of this method by mixing various elements to produce high entropy nanomaterials of several different crystal structures.

11NM.4

Influence of Atomization on the Particle Formation in Spray Flames. RICARDO TISCHENDORF, Fabian Fröde, Temistocle Grenga, Heinz Pitsch, Manuel Reddemann, Reinhold Kneer, Hans-Joachim Schmid, Sophie Dupont, *University of Paderborn, Germany*

The synthesis of nanoparticles by Spray Flame Pyrolysis (FSP) enables the production of industrially relevant materials with tailored properties and offers several advantages in comparison to established gas phase synthesis. However, the FSP synthesis chain involves a large number of simultaneous occurring physical and chemical sub-processes, which contributes to a high degree of process complexity and makes it hard to control. As initial step a liquid precursor mixture is atomized via a nozzle into a self-sustaining gaseous pilot flame. Subsequently, the ignition of the precursor mixture components follows, and specific particle structure properties evolve as function of nucleation, coagulation and sintering processes.

Our investigations showed that the evolution of particle properties can be highly influenced by solely varying the nozzle geometry. In particular, particle size distribution widths, primary particle sizes, crystal phase polymorphisms and the elemental composition (product purity) can be influenced under otherwise identical process conditions (identical dimensionless numbers We, Re). In our study two different nozzle configurations and two precursor compositions leading to a synthesis of iron oxide nanoparticles were exemplary compared. The flame and droplet characteristics were characterized by shadowgraphy, PDA/LDA measurements and by high-speed imaging. Particle samples were extracted in situ along the flame by using two complementary techniques, namely a hole in a tube diluter and a thermophoretic sampler system. The final particle outcome was comprehensively analyzed by state-of-the-art powder characterization techniques (FTIR and Raman spectroscopy, HRTEM, XRD, TGA-DSC-MS, BET, magnetometry). It was revealed that the precursor ignition as well as the particle residence times in high temperature regions are highly affected by the atomization principle.

12CA.1

Linking Gas, Particulate, and Toxic Endpoints to Air Emissions In The Community Regional Atmospheric Chemistry Multiphase Mechanism (CRACMM). HAVALA PYE, Bryan Place, Benjamin Murphy, Karl Seltzer, Chris Allen, Ivan Piletic, Emma D'Ambro, Rebecca Schwantes, Matthew Coggon, Sara Farrell, Emily Saunders, Lu Xu, Golam Sarwar, William Hutzell, Kristen Foley, George Pouliot, William R. Stockwell, *United States Environmental Protection Agency*

Reactive organic carbon (ROC) is ubiquitous in the atmosphere. Chemical mechanisms describe the atmospheric transformations of ROC from interactions with nitrogen oxides and other inorganic species allowing for air emissions to be linked to atmospheric pollutants with implications for climate and health. In this work, we present the first version of the Community Regional Atmospheric Chemistry Multiphase Mechanism (CRACMM) which provides transparent rules to map individual compounds to mechanism species and span the entire volatility range of atmospheric ROC. Radical chemistry was fully coupled to pathways leading to secondary organic aerosol (SOA), including autoxidation, providing additional constraints on ozone formation and allowing for consideration of SOA precursors such as phenolic and furan compounds not previously treated in chemical transport models. For novel ROC constituents, specifically semi- and intermediate volatility compounds, oxidation reactions were added that generate higher molecular weight products important for SOA formation and fragments contributing to the radical budget. In addition, explicit hazardous air pollutants were added resulting in 9 species covering 50% to 90% of the estimated cancer and non-cancer health risk due to inhalation. We use estimated emissions of ROC in 2017 from the EPA’s Air QUAlity TimE Series (EQUATES) project and their treatment in CRACMM to illustrate the mechanism coverage in carbon number, oxidation state, H:C, O:C, volatility, and reactivity space.

12CA.2

Particle Inhalation Triggered Reactivation of Latent Virus Infections - A New Link Between Air Pollution and the Development of Chronic Lung Disease? Lianyong Han, Verena Haefner, Ali Oender Yildirim, Annette Peters, Heiko Adler, TOBIAS STOEGER, *Helmholtz Zentrum München, Germany*

Background: Particulate air pollution and gammaherpesviruses are omnipresent in urban life, with basically all the global population breathing air exceeding WHO guideline limits and almost every adult infected by at least one herpesvirus type. Upon infection, herpesviruses persist lifelong in the host in a latent state, switching to the lytic, replicative phase only following reactivation. We have previously shown that pulmonary exposure to soot-like carbon nanoparticles (CNPs), a typical component of urban air pollution, can lead to reactivation of latent Murine gammaherpesvirus-68 (MHV-68) in the lungs of mice accompanied by an inflammatory response.

Hypothesis: We hypothesize that boosting the production of lytic proteins with subsequent immunomodulation by repetitive particle exposure scenarios contributes to development of chronic lung diseases.

Results: In a population-based study, using the German KORA FF4 cohort (2778 participants, 38 to 88 years), we detected an association between high particle number concentration and elevated Human herpesvirus 6 antibody serum titers, pointing to the human relevance of particle triggered virus reactivation. Twice repeated pulmonary dosing of MHV-68 infected mice with 50µg CNP, at an interval of 55 days, caused increased and prolonged lymphocyte accumulation in the airspace of MHV-68 infected and particle treated mice, not observed in animals infected or particle treated only. The over one week after the last exposure rising lymphocyte infiltration was accompanied by elevated inflammation and alveolar-damage markers, as well as histological changes indicating a progressive emphysema like pathology. Mechanistic investigations in MHV-68 infected macrophages uncovered by CNP exposure triggered p38 MAP-Kinase signaling as dominant driver of virus reactivation, and pretreatment with a pharmacological p38-inhibitor diminished CNP-induced virus reactivation in infected mice.

Conclusions: Together, our observations suggest that latent gammaherpesvirus infection of our lungs might pose a new pathway of susceptibility to air pollutants with inhibition of p38 as a preventive therapeutic target.

12CA.3

The Mobility Diameter of Soot Determines Its Angular Light Scattering Distribution.

GEORGIOS A. KELESIDIS, Patrizia Crepaldi, Martin Allemann, Aleksandar Duric, Sotiris Pratsinis, *ETH Zurich, Switzerland*

Characterization of soot agglomerates often relies on the angular distribution of their light scattering cross-section, C, that is based on the structure factor exponent, D_s, and asymmetry parameter, g, and depend on agglomerate mobility, d_m, and constituent primary particle, d_p, size distributions. Here, discrete element modeling (DEM) [1] is interfaced with discrete dipole approximation (DDA) [2] to determine C in the range of d_m= 60 - 450 nm with mean d_p = 9 - 26 nm that are most prevalent in fire detection, air pollution and climate change. Increasing d_m reduces the effective density, ρ_{eff}, and drastically increases D_s and g (by a factor of about 2-20), while increasing d_p or its geometric standard deviation, $\sigma_{g,p}$, increases ρ_{eff} but only slightly decreases D_s (10 - 20 %). Thus, the angular light scattering distribution of soot is largely determined by its d_m. Currently, constant D_s and g (obtained for large agglomerates, d_m > 200 nm) are used in laser diagnostics and climate models. This overestimates the d_m for small soot agglomerates by up to a factor of four and underestimates their radiative forcing efficiency by 10 %. So, relations between D_s, g and d_m are derived here and validated with data from our premixed flames [3] and literature diffusion flame and field data. These relations cover the evolution of D_s and g with d_m and nicely converge to the constant D_s for d_m > 200 nm. As such, they can facilitate the characterization of soot agglomerates by light scattering and help to quantify accurately the soot contribution to global warming.

References:

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12CA.4

Black Carbon Aerosol Number and Mass Concentration Measurements by Picosecond Short-range Elastic Backscatter Lidar.

ROMAIN CEOLATO, Andres Bedoya Velasquez, Frederic Fossard Fossard, Vincent Mouysset, Lucas Paulien, Sidonie Lefebvre, Claudio Mazzoleni, Christopher M. Sorensen, Matthew Berg, Jerome Yon, *ONERA*

Black carbon aerosol emissions are recognized as contributors to global warming and air pollution. There remains, however, a lack of techniques to remotely measure black carbon aerosol particles with high range and time resolution. This work presents a direct and contact-free remote technique to estimate the black carbon aerosol number and mass concentration at a few meters from the emission source. This is done using the Colibri instrument based on a novel technique, referred to here as Picosecond Short-Range Elastic Backscatter Lidar (PSR-EBL). To address the complexity of retrieving lidar products at short measurement ranges, we apply a forward inversion method featuring radiometric lidar calibration. Our method is based on an extension of a well-established light-scattering model, the Rayleigh-Debye-Gans for Fractal-Aggregates (RDG-FA) theory, which computes an analytical expression of lidar parameters. These parameters are the backscattering cross-sections and the lidar ratio for black carbon fractal aggregates. Using a small-scale Jet A-1 kerosene pool fire, we demonstrate the ability of the technique to quantify the aerosol number and mass concentration with centimetre range-resolution and millisecond time-resolution.

12EI.1 (Invited)

Uncovering Global-Scale Risks From the Atmospheric Oxidation of Particle Bound Commercial Chemicals in Air. JOHN LIGGIO, Qifan Liu, Li Li, Tom Harner, Xianming Zhang, Amandeep Saini, Hayley Hung, Wenlong Li, Chunyan Hao, Patrick Lee, Jeremy Wentzell, Shao-Meng Li, *Environment and Climate Change Canada*

Humans and ecosystems are exposed to tens of thousands of airborne chemicals, many of which are present in the particle-phase. However, only a miniscule fraction of these chemicals have been identified, as identifying harmful airborne chemicals, is largely based upon knowledge of parent chemicals in production. However, during their residence time in the atmosphere, emitted parent chemicals of concern are gradually transformed to thousands of products via photooxidation, such that tracking the complex mixture of products is an immense analytical challenge. While several studies have attempted to search through unidentified pollutants utilizing a non-targeted analysis technique (without targeting individual compounds), neither a traditional targeted, nor a non-target analysis approach in isolation are able to differentiate oxidation products from precursors, or determine their parent molecules of origin. Hence, the true environmental impact of a given parent chemical over the full atmospheric lifetime may be underestimated.

In the current work, a series of nine organophosphate flame-retardants (OPFRs) are investigated (as a relevant chemical of emerging concern), in laboratory studies to identify a large number of heterogeneous oxidation products (>190 species). We find that the transformation products identified in laboratory experiments are globally distributed across 18 megacities, representing a previously unrecognized exposure risk for the world’s urban populations. Finally, the full suite of OPFR product structures are used within in-silico models to estimate the persistence, bioaccumulation and toxicity of the products, demonstrating that transformation products can be up to an order of magnitude more persistent, and more toxic than the parent chemicals, such that the overall risks associated with the mixture of transformation products are also higher than the parent flame retardants. Together, this work highlights a strong need to consider atmospheric transformations when assessing the risks of commercial chemicals moving forward, to influence the development of future chemicals management.

12EI.2

Teaching an Old Dog a New Trick: Detecting Nanoplastics in Water using Aerosol Metrology. JAMES RADNEY, Christopher Zangmeister, Kurt Benkstein, Berc Kalanyan, *National Institute of Standards and Technology*

Microplastics (> 1 µm in diameter) are a contaminant of emerging importance due their exponentially growing environmental ubiquity. However, while they are a seemingly obvious next-level degradation product, nanoplastics (< 1 µm in diameter) have received considerably less attention. Because of their small size and mass, detection and separation of nanoplastics is challenging using classical methods, which are often limited to particles larger than 30 µm in diameter. Here we discuss the separation, sizing, counting and identification of nanoplastics released into hot water from food grade nylon bags and single use beverage cups. Particles were atomized from suspension using a Collision atomizer followed by size and mass classification by a differential mobility analyzer and aerosol particle mass analyzer, respectively. Additionally, particles were analyzed *in situ* using particle tracking analysis and *ex situ* by scanning electron microscopy, and Fourier-transform infrared spectroscopy of particles electrostatically deposited on Si substrates. In the case of single use beverage cups, we find that seven 300 mL hot beverage cups release enough sub-100 nm plastic nanoparticles for every cell in the human body at a size that is readily available for cellular uptake.

12EI.3

Morphology and Hygroscopicity of Nanoplastics in Sea Spray Determined by Humidified Tandem Differential Mobility Analysis Coupled to High-Resolution Time-of-Flight Aerosol Mass Spectrometry. SARAH PETTERS, Eva Kjærgaard, Freja Hasager, Andreas Massling, Marianne Glasius, Merete Bilde, *Aarhus University*

The environmental detection, fate, and transport of micro- and nanoplastics is becoming a topic of great interest in environmental chemistry, atmospheric chemistry, and public health. The presence of microplastics (diameter < 5 mm) in living tissue suggests a strong potential for numerous adverse health effects. Plastic particles accumulate in the ocean and recent works suggest that they can be transferred to the air with sea spray through wave-breaking action. The role of airborne nanoparticles (diameter < 1000 nm) in atmospheric chemistry and public health is largely controlled by particle size, morphology, and surface composition and coatings. Size-resolved aerosol mass spectrometry provides real-time characterization of submicron atmospheric particles. However, the analysis of nanoplastics in complex aerosol mixtures such as sea spray is severely limited by challenges associated with the detection limit of the instrument as well as the high background signal of the aerosol matrix. In this work we characterize the internal and external mixing state of sea spray aerosols spiked with nanoplastics. A humidified tandem differential mobility analyzer is used as a size and hygroscopicity filter, separating the nanoplastics from the sea spray, and an inline high-resolution time-of-flight aerosol mass spectrometer is used to characterize particle composition and internal mixing state. Aerosol from both synthetic and near-shore samples was internally and externally mixed. Aerosol enrichment and coating have a profound impact on aerosol hygroscopic water uptake and humidified size distributions, impacting aerosol efficiency in nucleating cloud drops and the oxidative aging of the particles. This work broadly contributes to the growing understanding of the detection, morphology, and hygroscopicity of micro- and nanoplastics in the lower atmosphere and their impact on the environment and the earth system.

12EI.4

Missing Intermediate- and Semi-Volatile Secondary Organic Aerosol Precursors Comprise the Majority of Total Gas-Phase Organic Carbon Emissions from Oil Sands Operations. DREW GENTNER, Megan He, John Liggio, Jenna Ditto, Lexie Gardner, Tori Hass-Mitchell, Christina Chen, Peeyush Khare, Jo Machesky, Bugra Sahin, John Fortner, Katherine L. Hayden, Jeremy Wentzell, Richard Mittermeier, Amy Leithead, Patrick Lee, Andrea Darlington, Samar Moussa, Shao-Meng Li, *Yale University*

Oil sands are an increasingly major source of unconventional oil with approximately 2 million barrels produced per day in Alberta, Canada through both open-pit surface mining and in-situ techniques. While emissions of volatile organic compounds (VOCs) are routinely reported, emissions inventories cannot explain large observed enhancements in secondary organic aerosol (SOA) production, inferring substantial “missing” emissions.

Aircraft-based measurements using a diverse suite of online and offline instruments were collected in the Athabasca Oil Sands region. Using measurements of total gas-phase organic carbon (excluding CH_4, CO, CO_2) and the Top-down Emission Rate Retrieval Algorithm (TERRA), hourly emission rates of total gas-phase organic carbon ranged 2-40 tonnes C hr^{-1}. This translated to approximately 200,000-500,000 tonnes C yr^{-1} for the largest surface mining facilities when scaled up via established NOx inventories.

These observed total organic carbon emissions greatly exceeded (e.g., 10-20x) those reported to national and regional emissions inventories. However, traditional VOCs and oxygenated VOCs each only accounted for a minor portion of the total carbon (i.e., <20% each), measured via whole air canister samples and online mass spectrometers (i.e., PTR-ToF-MS; Iodide-CIMS). Detailed chemical speciation of concurrent offline adsorbent tubes analyzed via gas chromatography with high-resolution mass spectrometry revealed abundant complex mixtures of intermediate-volatility and semi-volatile organic compounds (IVOCs, SVOCs) with maxima ranging C_{18}-C_{22}. On average, these IVOC-SVOCs accounted for 60% of measured total gas-phase organic carbon and were consistent with the weathered composition of oil sands measured in laboratory experiments. Further analysis of both airborne and laboratory data demonstrates the influence of non-combustion-related emissions pathways across extraction, processing, and waste management.

With total gas-phase organic carbon emissions around 1% of oil production and major gaps in inventory estimates, the results highlight the importance of routine IVOC-SVOC monitoring and lifecycle-wide emissions inventories with important implications for downwind SOA production and carbon deposition.

12HS.1

Health Effects of Emissions of Internal Combustion Engines: Success Story Joining Science, Technological Developments and Policy. ROGER MCCLELLAN, *Independent Advisor, Toxicology and Risk Analysis*

Spark ignition and compression ignition engines, the latter commonly referred to as Diesel engines, were invented in the late 1800s and quickly became a cornerstone of the industrial revolution. Typically, both are fueled by hydrocarbon fuels. The combustion process yields energy and a mixture of combustion products including carbon dioxide (CO2), carbon monoxide (CO), nitrogen oxides (NOx), carbon particles and hydrocarbons. These engines soon found wide application leading to advances in engine and fuel technology. An early concern for the gasoline engines was emission of carbon monoxide and for Diesel engines "black smoke". Later concern developed for "smog" produced by photochemical enhanced reactions between oxides of NOx and hydrocarbon compounds. Exhaust control systems were soon developed that required removal of Pb from to avoid poisoning catalysts in the exhaust system. The controls markedly reduced the CO, NOx and hydrocarbon emissions from gasoline spark ignition engines. In 1955 it was shown that organic extracts of exhaust painted on mouse skin caused cancer. In 1977, it was shown that Diesel exhaust particles contained an array of complex hydrocarbons that were mutagenic. In the 1980s it was shown that chronic inhalation exposure to high concentrations of Diesel exhaust caused lung cancer in rats. Early epidemiological studies yielded equivocal results for cancer induction. The International Agency for Research on Cancer (IARC) in 1988 categorized gasoline engine exhaust as "possibly carcinogenic to humans" and Diesel exhaust as "probably carcinogenic to humans". Further action was taken to remove the "bad actors" from Diesel exhaust. In 2012 IARC elevated its classification of exposure to Diesel to "carcinogenic to humans" without distinguishing between emissions from traditional and new technology engines. Nonetheless, this is a remarkable success story of using science to inform both technological advances and regulatory policy. Recently, Societal concerns have shifted to "climate change" which is driven by concern for "greenhouse" gas emissions, including carbon dioxide, from internal combustion engines. This presentation will conclude with speculation as to options for the path forward.

12HS.2

Turn on the Light: The Evolution of Aerobiology and Airborne Disease Studies in the United States Before Aerosols, 1930-1955. GERARD FITZGERALD, *Independent Scholar*

Research and debate during the first year of the pandemic in the United States about the possible airborne spread of COVID-19 by either droplet nuclei or aerosols can be historically contextualized by examining the evolution of research on the airborne spread of disease by scientists, engineers and physicians that began during the interwar period to create the discipline of aerobiology. This paper examines the research of Professor William Firth Wells, whose work at the Harvard School of Public Health and the Airborne Disease Laboratory at the University of Pennsylvania Medical School. In particular, his research into the biophysical aspects of small droplets of dried material that traveled through the air that he christened droplet nuclei in 1934. Wells' research was focused on not only understanding the dynamics of the spread of airborne infection, but in also trying to create the technological means to control or prevent the spread of infectious airborne bacteria and viruses. The American research program in aerobiology, which changed course in part during World War II, illustrates the importance of understanding the development of biology and biomedicine during a transformative period in American history.

12HS.3

Evolution of AAAR Topics over the Past 40 Years: An Automated Analysis. Brandon Beattie, Supraja Gurajala, SURESH DHANIYALA, *Clarkson University*

Aerosol science is an evolving field with deep connections to the past. And presentations in AAAR conferences in the form of platform talks, posters, and plenaries represent this evolution. The 40th year of AAAR provides an opportunity to reflect on the continuity and changes in the research directions of the association members. The conference abstracts over the past 19 years (2003 to 2021) provides a rich data set to understand the evolution of the field. In this study, we analyzed the abstracts to understand changes in field as represented by changing research topics and terminology. For our analysis, we pre-processed the data using natural language processing toolkit and identified topics using Latent Dirichlet Allocation (LDA) model. Further analysis of the data allowed us to determine changes in the frequency of these topics over time and identify emerging topics that have recently risen in popularity. We will present the overall approach used for automatic identification of topics and the major findings from this study.

12HS.4

The Creation and Evolution of *Aerosol Science and Technology*. PHILIP K. HOPKE, *Clarkson University and University of Rochester*

As part of the founding of AAAR in 1982, David Shaw, David Ensor, and Ben Liu also initiated the creation of its journal, *Aerosol Science and Technology*. With the growing field of aerosol science and technology, it was decided that there was a second journal to provide additional opportunities to publish that were previously only available through the *Journal of Aerosol Science*. Although it was published by Elsevier, AAAR retained the copyright allowing the association to make critical decisions about the journal normally retained by the publisher although there were some issues that needed to be resolved. In 1990, the AAAR leadership decided it was necessary to change the editorial staff and a competition was organized by the Publication Committee. That is where I came in. A number of further changes occurred including a change in publisher and in 2002, we moved to a more routine rotation of the Editor-in-Chief. A variety of details will be presented.

12ID.1

Chronic Ambient Air Pollution and Acute COVID-19 Disease Severity or Death among Confirmed Cases in Southern California. Michael Jerrett, MICHAEL KLEEMAN, Yiting Li, Yusheng Zhao, Anikender Kumar, Jason Su, Claudia Nau, Deborah Young, Rebecca Butler, Christina Batteate, Richard Burnett, *University of California, Davis*

A growing body of evidence links ambient air pollution to COVID-19 incidence, severity, and death, but many studies have important limitations: (i) limited ability to control for important confounders, (ii) relatively simplistic exposure assessments, (iii) limited exploration of other environmental variables such as temperature and humidity. It is desirable to address these limitations to fully understand whether air pollution exposure worsens the prognosis for patients infected with COVID-19.

Here we analyzed air pollution effects on COVID-19 outcomes using a retrospective cohort of 316,224 patients who were diagnosed with, or tested positive for COVID-19 during 06/01/2020 up to 1/30/2021. The cohort was created using electronic health records data (EHR) from Kaiser Permanente Southern California (KPSC). Chronic air pollution exposure fields were developed across the study region using chemical transport models (CTMs) and Land Use Regression Models (LURMs) with a spatial resolution of 1 km. The exposure fields included PM2.5 mass, PM0.1 mass, and several physio-chemical constituents of PM2.5, source tracers as well as ozone and NO2. We used Cox proportional hazards models to study relationships between air pollution and COVID-19 outcomes with adjustment for potential individual and neighborhood variables. All models were stratified at baseline for age, sex and race-ethnicity. We controlled for potential non-independence at the census tract level. We conducted several subgroup analyses and examined the dose-response curves for the pollutants with significant effects.

Results indicate significant air pollution effects on the risk of death for PM2.5 mass, PM0.1 mass, and several of the particle species or source tracers, including PM2.5 nitrates, PM2.5 elemental carbon, PM2.5 on-road diesel, and PM2.5 on-road gasoline. Effects for PM2.5 mass were only slightly reduced in the multipollutant models. Lower temperatures and lower humidity were associated with higher risks for COVID-19 death. Both of these variables were selected as confounders in all air pollution models. Based on these results, we conclude that there is a high likelihood that chronic ambient air pollution exposures contribute to a higher risk of death within 90 days of COVID-19 infection. Such findings may lead to a re-evaluation of whether current air pollution standards need to be tightened as another measure to protect people from the adverse effects of COVID-19 and from future pandemics.

12ID.2

Environmental Stability of Enveloped Viruses is Impacted by the Initial Size of Droplets. Andrea French, ALEXANDRA LONGEST, Jin Pan, Peter Vikesland, Nisha Duggal, Seema Lakdawala, Linsey Marr, *Virginia Tech*

Respiratory viruses must maintain stability, or infectivity, in the environment for efficient spread and transmission to occur. Environmental stability can be influenced by many factors, including virion structure, temperature, relative humidity, droplet composition, and fomite surface material. The objective of this study was to determine the effect of size and relative humidity (RH) on viability of respiratory viruses in droplets. We measured the impact of droplet size (volumes of 50, 5, and 1 µL) and RH (40, 65, and 85%) on the stability of two enveloped viruses: bacteriophage Phi6 and influenza A virus. The drying time, or time it took for a droplet to reach quasi-equilibrium or a plateau in mass, ranged from 0.5 hours for a 1 µL droplet at 40% RH to 11 hours for a 50 µL droplet at 85% RH. The macroscale physical characteristics of the droplets at quasi-equilibrium varied with RH but not with the initial droplet volume. We observed more rapid virus decay when the droplets were still wet and undergoing evaporation and slower decay after the droplets had reached quasi-equilibrium. Initial droplet volume had a major effect on virus viability over the first few hours. There was no significant difference in virus decay in 5 µL and 1 µL droplets for H1N1pdm09 at different RHs but there was in the larger 50 µL droplets. Similar observations were confirmed in limited experiments with SARS-CoV-2. Overall, this study suggests that virus decay is closely correlated with the extent of evaporation, which is controlled by RH and is likely a proxy the solute concentrations in the droplet. Taken together, these data suggest that accurate assessment of transmission risk requires the use of physiologically relevant droplet volumes. This is important in considering the applicability of previous studies on virus persistence in large droplet volumes.

12ID.3

Detailed Exploration into the Underlying Physicochemical Properties of Aerosol that Govern How Long SARS-CoV-2 Remains Infectious in the Aerosol Phase. ALLEN E. HADDRELL, Mara Otero-Fernandez, Henry Oswin, Tristan Cogan, Jamie Mann, Thomas Hilditch, Jianghan Tian, Daniel Hardy, Darryl Hill, Adam Finn, Andrew Davidson, Jonathan P. Reid, *University of Bristol*

The COVID-19 pandemic has exposed the need for an improvement in our understanding of the transmission of respiratory pathogens, the shortcomings in which have manifested in the prolonged debate surrounding likelihood of the transmission of SARS-CoV-2 being airborne (1).

A detailed understanding of the airborne decay of the virus, and how this is affected by environmental parameters such as relative humidity, temperature, air content and aerosol composition, will provide the necessary insights into the relative risk of different environments and the potential impact of measures such as social distancing, masks and ventilation on public health. These insights may also allow the implementation of new and more effective infection control strategies such as indoor environmental (e.g. humidity, temperature, HNO3, CO2) controls.

To be presented are the outcomes of study, in which a novel approach was used to study the underlying mechanisms by which SARS-CoV-2 virus is inactivated in the aerosol phase. This approach involves the coupling together of two single particle analysis instruments:

1) Comparative kinetic electrodynamic balance (CK-EDB) – Measures the physicochemical properties of individual droplets, including evaporation rate, phase change, pH, hygroscopic growth curve, etc.

2) Controlled electrodynamic levitation and extraction of a bioaerosol onto a substrate (CELEBS) – Measures the loss of viral infectivity in the aerosol phase as a function of time (in this study, from 5 seconds to >40 minutes), environmental conditions (relative humidity, temperature, [CO2(g)], [HNO3(g)]), and droplet composition (artificial saliva, MEM, [NaCl]). In this study, the delta variant of SARS-CoV-2 was probed.

Through combining these techniques, we have coupled together the changes in the physicochemical properties of the aerosol phase with viral infectivity. This is done in the same conditions and (uniquely) on the same time scale. Making these measurements on the same time scale is unique to this approach and is essential if these complex relationships are to be accurately interpreted. The results of this study have afforded detailed mechanistic insights into the loss of viral infectivity in the aerosol phase. Specifically, it will be presented that aerosol pH (alkaline) and aerosol phase are the primary drivers of loss of infectivity in the aerosol phase.

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12ID.4

Nasal Delivery of Encapsulated Recombinant ACE2 as a Prophylactic Drug for SARS-CoV-2. ALBERTO BALDELLI, Hale Oguzlu, Yigong Guo, Hui Xin Ong, Daniela Traini, Anubhav Pratap-Singh, *The University of British Columbia*

Covid-19 has caused a global pandemic, and worldwide, the number of deaths exceeded five million. Even though medical research efforts have developed vaccines, vaccination worldwide faces several challenges. As well, several mutations can jeopardize the efficacy of these vaccines. Most research studies the production of a vaccine that uses intravenous (IV) or intramuscular delivery to boost. For such a purpose, one might think that the most logical approach would be to decrease or repress the number of cell receptor ACE2. While as humans, our heart and lung produce soluble ACE2, a recombinant form of the cell receptor Angiotensin-Converting Enzyme2 (rhACE2) version is accessible on the market. rhACE2 can serve as an interceptor of SARS-CoV and other selected coronaviruses by binding to the surface of the viral particle. We aim to develop a non-invasive drug involving the advantages of rhACE2 against SARC-CoV-2. Spray freeze drying (SFD) is the only spraying technique that allows the control over the properties of sprayed powders and the use of low temperatures. The affinity of rhACE2 and the spikes protein of SARS-CoV-2 has already been explored, and the idea of using rhACE2 as a possible treatment of Covid19 has been published in a few research studies. However, the concept of generating an inhalable form of rhACE2 to be delivered to the nasal cavity as prophylactic is new. We encapsulated rhACE2 maintaining its stability and affinity with spike proteins of SARS-CoV-2 at 97 and 82 %, respectively. Using the MTS assay, we demonstrated that rhACE2 protein does not negatively affect Calu-3 and RPMI-2650 cell viability. We ultimately show that the encapsulation procedure enhances the cellular uptake by 93 %.

12IM.1

Characterization of Ambient Metal Particles in Real Time Using Atomic Emission Spectroscopy: Urban and Rural Environments.

Hanyang Li, Leonardo Mazzei, Christopher Wallis, ANTHONY S. WEXLER, *University of California, Davis*

Exposure to toxic metal particles is known or suspected to affect human health. In order to help underrepresented communities determine the source of toxic metals and evaluate future actions that may reduce emissions in their neighborhoods, we recently developed a toxic-metal aerosol real-time analyzer (TARTA). TARTA is relatively inexpensive (~ $3,000), compact (1 ft cube), high time resolution (30 minutes), and power-efficient (< 30 W).

In this study, TARTA is used to measure metal emissions of PM2.5 from different ambient environments, including the emissions of vehicles traveling through the Caldecott tunnel, the urban emissions near downtown Sacramento, and the agricultural emissions from a rural background site in Davis. In parallel, we collected particle samples on Teflon filters for X-ray fluorescence (XRF) analysis of trace metals and at the Sacramento site monitored the elemental composition using the Cooper Environmental's Xact 625 Ambient Metals Monitor. The analytical results obtained by in situ Xact and offline XRF analysis allow for the evaluation of the accuracy and sensitivity of TARTA.

We also identified the major sources of metal particles in each region using the positive matrix factorization (PMF) model. For the tunnel environment, the best association exists between Fe, Cr, Mn, Cu, and Zn (0.61 < R < 0.96), suggesting that they are from similar pollution sources (e.g., the exhaust emission from vehicle engines and automotive brake and tire wear). On the other hand, the rural site shows the best correlation among crustal elements (including Na, Mg, Ca, and K with R > 0.8), which are blown by wind and resuspended by cattle and tractor operations near the sampling site.

12IM.2

External Proton Induced Gamma and X-Ray Emission (PIGE and PIXE) for Elemental Analysis of Dust Pollutants.

GUNNAR BROWN, William Kacey, Graham Peaslee, *University of Notre Dame*

Proton Induced Gamma and X-ray Emission (PIGE and PIXE) are standard Ion Beam Analysis (IBA) techniques at accelerator facilities to precisely measure isotopic and elemental abundances in samples such as environmental aerosol samples. While performing this in vacuum has been standard procedure and offers excellent sensitivities, it also limits the number and size of samples that can be run. To increase productivity, the St. Andre facility at Notre Dame has been conducting PIGE and PIXE experiments *ex vacuo* expanding the application of these IBA techniques as rapid scanning techniques. Large sample throughput and rapid analysis increases viability of these techniques for health and environmental applications, particularly time sensitive projects and large scale sampling campaigns such as indoor air and dust across a city. This technique can be applied to quantifying *ex vacuo* measurements of particulate matter (PM) aerosol pollution which would benefit from rapid screening due to the large amounts of samples. Preliminary data from Indiana will be discussed.

12IM.3

Validation and Demonstration of the “Chemspot” Instrument for Measuring Aerosol Composition. PURUSHOTTAM KUMAR, James Hurley, Nathan Kreisberg, Braden Stump, Pat Keady, Susanne Hering, Andrew Grieshop, Gabriel Isaacman-VanWertz, *Virginia Tech*

Online measurements of the chemical composition of particulate matter have typically relied on expensive and complex research-grade instruments based on mass spectrometry and/or chromatography. Routine monitoring necessarily relies on low-cost alternatives that can be readily operated autonomously. Yet existing methods provide limited chemical information about particulate matter. For organic aerosols, these instruments do not provide data on the degree of oxygenation of particles, a critical parameter in understanding the transformations and impacts of organic aerosols. To bridge this gap, a new instrument “Chemspot” has been developed that grows particles with water condensation, impacts them onto a passivated surface with low thermal mass, and uses stepped thermal desorption of analytes to a combination of Flame Ionization Detector (FID) & Flame Photometric Detector (FPD) and then to a CO_2 detector downstream of the FID/FPD setup. We present here the intercomparison of the “Chemspot” instrument with other reference/research-grade instruments to measure aerosol mass, volatility, and elemental ratios (O:C, S:C). We also demonstrate the capability of continuous and autonomous operation of “Chemspot” for multi-week periods. Two “Chemspot” prototypes were run autonomously in parallel, alongside an Aerosol Chemical Speciation Monitor (ACSM) and a Scanning Electrical Mobility Sizer (SEMS), sampling ambient air in Blacksburg, Virginia for two weeks. Initial results indicate that aerosol mass measured by “Chemspot” correlates well ($R^2 = 0.95$) with measurements using other techniques. We will further discuss in detail the accuracy and uncertainty in measured elemental composition and volatility resolution.

12IM.4

A Stable Water Dispersed Calibrant for Refractory Black Carbon (rBC) in the Soot Particle Aerosol Mass Spectrometer (SP-AMS). ANITA AVERY, Edward Fortner, Leah Williams, Arthur J. Sedlacek, Shreya Joshi, Claudio Mazzoleni, Timothy Onasch, *Aerodyne Research, Inc.*

The Aerodyne Soot-Particle Aerosol Mass Spectrometer (SP-AMS) utilizes a 1064 nm laser to vaporize refractory species before ionizing and detecting with a time-of-flight mass spectrometer. Quantifying the refractory black carbon (rBC) mass is performed via calibration with known quantities of regal black (RB, Regal 400, Cabot Corporation). Other calibrants can be used, including fullerene soot (for high Cx fragments), which is the standard calibrant for the Single Particle Soot Photometer (SP2, Droplet Measurement Technologies) and Cab-O-Jet (CJ, Cab-O-Jet 200 and 300, Cabot Corporation) which is used in black printing ink. Hydrophobic particles like RB are difficult to use in a standard, water-based atomizer and need to be continuously agitated to maintain a constant output, while CJ are stable in aqueous solution. Here we compare two types of CJ, with different surface functionality, with the standard SP-AMS calibrant, RB. We compare these for mass spectral similarities at C1-C5, particle beam width in the AMS, and relative ionization efficiency. CJ and RB exhibit nearly the same C1-C5 low carbon fragmentation pattern but show some differences in other spectral features related to the surface functional groups containing sulfur (CJ-200) or oxygen (CJ-300). Based on mass-mobility effective density measurements, the SP-AMS Cx sensitivity to CJ appears to be higher than to Regal Black. We explore this difference based on measured particle beam widths inside the SP-AMS and with scanning electron microscope (SEM) imaging. This work details the physical and mass spectral properties of RB and CJ and recommends a new calibration protocol based on CJ.

12NM.1

Mass Production of Multilayer Graphene via Chamber Explosion. CHRISTOPHER M. SORENSEN, Justin P. Wright, Shusil Sigdel, Arjun Nepal, Stephen Corkill, Jun Li, Ranjith Divigalpitiya, Stefan Bossmann, *Kansas State University*

We describe a method to create high-quality, multi-layer, turbostratic graphene aerosol gels by detonating fuel rich mixtures of acetylene, ethylene, toluene and other hydrocarbons with oxygen in a multi-liter chamber. Important characteristics of our controlled explosion synthesis method include its simplicity, fill the chamber with gases, ignite with a spark, and collect the graphene; it uses industrially available gases; it requires no catalyst, no toxic chemicals; it is exothermic, hence has very low energy needs; and the by-product is H_2 + CO, i.e. “Syngas”, which can be separated for the H_2 and/or used as feedstock for Fischer-Tropsch reactions. We will also describe scale-up of this method and the consequent production plant. The physics of the method lies in the constant volume of the chamber, hence, via the first law of thermodynamics, no work is done and all the chemical energy released by the explosive combustion creates high temperatures leading to graphene rather than soot. We forecast that this flexible, gas phase chemistry, constant volume explosion method can be extended beyond carbon to the rest of the Periodic Table to create aerosols and aerosol gels of a wide variety of novel materials.

12NM.2

The Release and Resuspension of Airborne Nanoparticles from Nano-enabled Consumer Sprays. RUIKANG HE, Jie Zhang, Gediminas Mainelis, *Rutgers, The State University of New Jersey*

With the increasing application of nanotechnology, many nano-enabled consumer products have been introduced into the market. Unfortunately, studies have shown that consumers could be exposed to airborne nanoparticles and their agglomerates stemming from such products, thus increasing the potential for negative health effects.

This study investigated the release and resuspension of particles from surfaces due to the application of three Ag-based, three Zn-based, and one Cu-based consumer sprays used indoors, focusing on nano-sized particles. The release and resuspension of particles were investigated in a newly-constructed 2.8×1.6×2.4 m^3 chamber with either carpet or vinyl flooring. Particles were sprayed at 1.1 m height and, after settling, they were resuspended by a walking adult. The resuspended particles were measured at 0.3 m height with a Scanning Mobility Particle Sizer 3986 (SMPS) and an Aerodynamic Particle Sizer 3321 (APS) (both by TSI, Inc., Shoreview, MN, USA) in a combined size range of 14 to 20,000 nm.

For particles smaller than 100 nm, the number concentration reached as high as 10^9 /m^3 during spraying and up to 10^8 /m^3 during resuspension, and the concentrations varied among different products. For particles < 50 nm, higher concentrations were resuspended from the vinyl surface than from the carpet. The resuspension from the carpet resulted in higher particle number concentrations than from vinyl for particles between 50 and 1000 nm. Moreover, according to the composition analysis, Ag, Zn, and Cu were detected in the sprayed and resuspended particles, including nano-sized particles.

The results suggest that for consumer products both labeled and not labeled as nanotechnology-based, the spray and resuspension of the product can release airborne nanoparticles. Furthermore, the number concentration of resuspended particles depends on the product type and flooring materials.

12NM.3

In-Situ Laser Diagnostics of Metal Nanoparticles during Their Flame Synthesis in the Reactive Spray Deposition Technology. EVANGELOS K. STEFANIDIS, Thomas A Ebaugh, Stoyan Bliznakov, Leonard Bonville, Radenka Maric, Francesco Carbone, *University of Connecticut*

The development of proton exchange membrane fuel cells (PEMFCs) and water electrolyzers (PEMWEs) requires enhanced techniques for manufacturing highly active and durable catalysts and Membrane Electrode Assemblies (MEAs). Reactive Spray Deposition Technology (RSDT) is an atmospheric pressure flame-assisted MEA fabrication methodology that combines catalyst synthesis and MEA manufacturing in one step. In RSDT, the properties of metal nanoparticles with high catalytic activity are tailored via control of the flame boundary conditions, and the synthesized catalyst nanoparticles are deposited directly on the proton conductive membrane. Currently, the RSDT process parametrization is based on the post-deposition ex-situ analysis of the fabricated catalysts. Laser diagnostics can expedite the parameters optimization significantly by measuring some characteristics of the synthesized nanoparticles in-situ in the flame during their synthesis.

In this work, we demonstrate the capabilities of the laser diagnostic system for the in-situ characterization of nanoparticles synthesized by the RSDT using three different flames. Specifically, two flames are fueled by a solution mixture of xylene, acetone, propane, and platinum acetylacetonate but differ in the reactant flow rates, whereas the third flame relies on a solution mixture of xylene, ethanol, diethylene glycol monoethyl ether (DGME), propane, and iridium acetylacetonate. Laser-Induced Incandescence (LII) is used to characterize the dilution and the change in optical properties of the synthesized nanoparticles, whereas Laser Light Scattering (LLS) is used to measure their size as they travel and age downstream of the flame. The in-situ results from both LII and LLS techniques are compared with ex-situ results obtained by analyzing thermophoretic samples of the nanoparticles acquired by High-Angle Annular Dark-Field Scanning Transmission Electron Microscopy (HAADF-STEM). We found that the laser measurements of LII and LLS agree with the HAADF-STEM results. Finally, we measured the Raman scattering spectra of the iridium nanoparticles synthesized in the third flame to identify possible chemical functional groups on the nanoparticles' surface.

12NM.4

Aerosol-based 3D Printing to Improve Resolution and Simplicity. SHALINEE KAVADIYA, Pratim Biswas, *University of Miami*

3D printing processes have made manufacturing and designing easier and faster because of their cost-effectiveness, automation, and production times. There are several 3D printing processes from simple to complex and developed based on material feedstock. Essential characteristics to consider for a 3D printing process are – resolution, simplicity, and feed material. The simplest 3D printer, which can be found in several homes now a days, is a fused deposition modeling (FDM) printer. FDM printers are easy to operate but only take polymer filament feed and can print a maximum resolution of 100 µm. Powder bed fusion, which is a common process for 3D printing metals, is complex and requires a high-power laser and enclosure.

In this work, we developed a simple 3D printing process that can print small length scales (< 50 µm) and does not require any special environment during printing. As a test, we printed 3D structures with polyethylene glycol with a print size of 41 µm. The printing feedstock is generated using an aerosol process which enables printing finer length scales. Further, the feedstock can be controlled at any time to print the desired resolution and material. There are several important process parameters that control print resolution and quality. These will be discussed in the presentation. Our goals in developing this technique are – 1) to improve the printing resolution of polymer 3D printing retaining the process simplicity and 2) to build a simple 3D printer for metal 3D printing that can print at high resolutions.

Reference

Kavadiya and Biswas (2022), Improving the resolution and simplicity through aerosol processes, in preparation.